Science and Mathematics Education Centre

Student Outcomes and Learning Environments at the Tertiary Level in New Zealand: The Development of an Assessment Framework

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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ABSTRACT

This thesis reports the findings of a case study into the outcomes and learning environments of students studying for a Diploma of Technology at a New Zealand Tertiary Education Institution. The primary focus of the study was to develop an assessment framework that would facilitate simultaneous assessment of the local Institute achievement-based Diploma of Technology and the competency-based assessment of a National Diploma that the local diploma subsumed. From this primary focus on assessment, the study provided the opportunity to undertake a grounded theory study of literature that impacted on the learning environment, supported the necessity to rationalise the student learning outcomes from both an academic and work skill perspective, and presented a suitable situation in which to take a fresh look at the method of grading and marking students' assessment material.

The grounded theory study grew out of the need to condense the vast amount of literature that was gathered in the process of searching for background material to use in the building of a foundation on which to construct a dual assessment model. Although no literature was found that specifically dealt with the simultaneous dual assessment, a large amount of material was found that related to various aspects of the learning environment. Through the process of a grounded theory study, this material was condensed into categories of data that in turn were used to develop a theoretical model of an 'ideal' learning environment. Into this model was also added the results of a questionnaire based research study into the perceived need for diploma graduates to have a range of employability skills. This study involved a range of employers who considered themselves likely to employ a diploma graduate.

Because the learning outcomes for the two diplomas covered essentially the same material yet the actual wording of the outcomes were substantially quite different, there was a need to rationalise the sets of learning outcomes for each diploma. This process led to a common set of outcomes that in turn were used as a focus for students' learning and assessment. Once these common outcomes had been identified, a rubric based marking/scoring system was developed so that both

students and teacher could quickly grade students' assessment material and then convert that grade into a mark. The use of the grade facilitated the assessment of achievement against a unit standard and the resultant marks satisfied the need for an achievement mark.

The results and findings from the various studies were then translated into a working model that was used for two courses over one semester. Various other research methodologies were then used in order to provide some evaluation of the working model.

The thesis does present some of the difficulties facing tertiary teachers in an environment that is becoming more and more of a production line business rather than a service to provide learning opportunities for students. However it also presents solid evidence that teachers can take measures to prove themselves through study and initiative and provide those focussed learning environments where students can attain the outcomes necessary for a successful career in tomorrow's world.

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ACRONYMS

ABET	Accreditation Board for Engineering and Technology
AIPENZ	Associates of the Institute of Professional Engineers of New Zealand
APNZ	Association of Polytechnics in New Zealand
ARG	Assessment Reform Group
CBE	Competency-based education
CEO	Chief Executive Officer
DC	Direct Current
Dip Tech	Diploma in Technology
ELEI	Electronics Laboratory Environment Inventory
ETITO	ElectroTechnology Industry Training Organisation
EWRB	Electrical Workers Registration Board
HOD	Head of Department
IPENZ	Institute of Professional Engineers of New Zealand
ITF	Industry Training Federation
ITO	Industry Training Organisation
MYTEC	Pseudonym for the Institute of Technology where the author taught
NCEA	National Certificate of Educational Achievement
NCVER	National Centre for Vocational Education Research
NDE	National Diploma in Engineering
NQF	National Qualifications Framework
NZCE	New Zealand Certificate in Engineering
NZNDE	New Zealand National Diploma in Engineering
NZQA	New Zealand Qualifications Authority
OASIS	Online Access Student Information System
OECD	Organisation for Economic Co-operation and Development
QA	Qualifications Authority
RCC	Recognition of Current Competency
RPL	Recognition of Prior Learning
TCA	Technicians Certification Authority
TCB	Trades Certification Board
TEAC	Tertiary Education Advisory Commission
US	Unit Standard
VET	Vocational Education and Training

CHAPTER 1

RATIONALE FOR THE STUDY

1.1 OVERVIEW

This study investigates a problem that I faced as a tertiary academic staff member (or teacher) teaching a selection of electrical and electronic courses for the first year of a two-year diploma level programme of study. The courses under study were part of a local institute-developed diploma and because the course content was very similar to a national diploma, the local diploma was considered to subsume the national diploma courses. The one form of delivery or learning environment dealt with the same or very similar course content, but the local diploma required performance-based assessment against learning outcomes detailed in a prescription, while the national diploma required competency-based assessment against the criteria of the unit standards. Thus the students required a learning environment with an assessment framework and instruments that would meet the requirements of the two different forms of assessment. It is important to note that it was not a case of simply using both forms of assessment in the same course (e.g., achievement-based for theory and competency-based for practical skills) but the same theory was to be assessed simultaneously using the two different approaches. Into this learning environment came the challenge of the growing knowledge-based society with the associated need for employability skills as opposed to the traditional need to focus principally on academic qualifications. Encompassing this was the difficulty of inflexibility created by the imposition of student and peer expectations. The specific problem then became one of how to assess the same material to produce the required grade or mark for the performance-based course and the required competency status for the standards-based course, provide the advantages of a sound assessment framework, minimise the risk of over-assessment, and provide a flexible and easy-to-manage assessment structure.

1.2 BACKGROUND TO THE STUDY

Up until approximately 50 years ago, there were two principal levels of engineering education available in New Zealand. These were the apprenticeship scheme leading to a national trade and advanced trade certificate, and the professional engineering degree. Because of the recognised need for an intermediate level qualification, the New Zealand Certificate in Engineering (NZCE) was established across several fields of disciplines. The NZCE was originally developed as a five year, part-time programme aimed mainly at those engineering trades people who had attained their particular trade qualifications and who were still working in their discipline. Many students studied for their NZCE via correspondence and this fitted in well with their working life. Over the years as more local technical institutes were established, students were able to attend night classes in order to continue their education. The qualification was traditionally studied as a theoretical night class or correspondence course, and supporting laboratory work was often done on a short-term (e.g., one week), full-time block course. As the evolution of the programme continued, the NZCE finally became a two-year full-time programme accessible to students direct from secondary school.

The method of assessment for the NZCE courses retained the traditional approach of norm-referenced, achievement-based assessment set by the prescriptions that included a relatively loosely defined set of learning outcomes and an even more loosely defined set of assessment criteria for each outcome. Student learning for each course was assessed by the particular institution's teaching staff using a mix of traditional tests, laboratory reports and assignments as specified by the prescriptions in order to produce a course mark. Coursework marks and the examination marks were considered separately and a minimum percentage was required in each before a pass in the course was granted.

The achievement based external examination was prepared by a nationally appointed examiner (usually a practising teacher in one of the teaching institutions) and used to produce an examination mark. The examination was norm-referenced and the pass mark would be moved if necessary to compensate for 'easy' or 'difficult' examinations. Any change in the format of the examination or in the style or content of a particular question, for example, due to a change in examiner who wrote questions that reflected their individual interpretation of the prescription, could easily cause an otherwise average student to fail. A pass for the course required a 50% or greater mark for both the coursework and for the examination.

Because the examination was a major and essential part of accumulating marks for the student, the learning and internal course assessment process became directed by the examination. Tests were written using questions based on those from the readily available, past examination papers and students prepared themselves for the examination by answering past examination paper questions. One of the problems with this approach to assessment is that while effort was made to write an examination to meet the loosely defined learning objectives, there was often some significant content that favoured some students and disadvantaged others. This was particularly noticeable when a change in the nationally appointed examiner occurred and there were years when there was an unexpected and noticeable shift in the format and objective of the examination questions. In order to promote co-operation between polytechnics and to provide a means of moderation, a consortium of polytechnics teaching electrotechnology courses had existed for some time. This consortium shared information and ideas on teaching, equipment and resources, provided examiners for the various courses and provided a means of self-moderation.

Teaching in these courses tended to become object oriented like the style of questions contained in previous examinations and copies of past examination papers were made available to students. The style of question used in the coursework tests generated by the academic staff member teaching the course usually reflected the type of question likely to be found in the current examination. The emphasis on the tests was summative rather than formative and they were used to provide marks for the overall score, rather than a method of supporting learning. This traditional examination culture is an example where teachers and students can easily focus on the examination and learning is more often than not an exercise in rote learning and cramming before the examination. Students miss out on being involved in the learning process and the opportunity to acquire many necessary learning skills. They tend towards becoming a passive learner and see the examination result as the only worthwhile outcome. Students drive teachers into teaching for the examination and teachers end up controlling the class in such a way as to promote coverage of the course content in the hope that learning occurs. It was not uncommon to hear teachers talk of "having to get through the work" which implied that the quantity of instructional delivery was more important than the learning process.

Over the past two decades, there has been a trend in many countries towards standards-based assessment. In New Zealand, the New Zealand Qualifications Authority (NZQA) was established under legislation to develop a framework for national qualifications in secondary schools and in post-school education and training (Education Amendment Act, 1990). The result of this directive was the National Qualifications Framework (NQF), which is used to register the unit standards that constitute a range of learning and training opportunities for New Zealand qualifications (Ministry of Education, 1997). Reasons for establishing the framework were based on the fact that New Zealand needed a clearer currency in the labour market, the current system of qualifications had become progressively confused, many qualifications did not link well with one another, the value of qualifications was in doubt, holders of qualifications were not always as proficient as their qualifications suggested and there no consistent regulations in place to establish and stabilise values on a systems-wide basis (Barker, 1995). An example was the electrical industry where the education of electrical apprentices was under the control of the Trades Certification Board (TCB), training under the control of employers and the apprenticeship scheme, registration of electrical workers under the control of the Electrical Workers Registration Board (EWRB) and the next level of education (i.e. the NZCE or diploma level qualification) under the control of the Technicians Certification Authority (TCA). Immediately after the establishment of the NZQA, administration of the trade qualifications and the NZCE qualification were transferred from independent controlling authorities or boards, to the NZQA. The Electrical Registration Board retained the right to set and mark the trade certificate level theory and regulation examinations. At the same time, Government policy had promoted the devolution of the control of tertiary education from central organisations such as NZQA and traditional programmes began to be phased out over a period of time. Many of those traditional programmes incorporated the norm-referenced, achievement-based assessment and the NZCE was a typical example.

As the traditional programmes were being phased out, the opportunity existed for both training providers and Industry Training Organisations (ITOs) to establish new qualifications. While national qualifications became the responsibility of ITOs, some training providers such as Institutes of Technology (or Polytechnics) developed their own qualifications to provide either greater flexibility and/or future learning opportunities. The new National Diploma qualifications were based on Unit Standards that had been registered on the NQF. Unit Standards were predominantly competency-based or standards-based assessed.

The ElectroTechnology Industry Training Organisation (ETITO) was given the responsibility to oversee the development of industry standards and national qualifications in the electro technology disciplines. This resulted in the National Diploma in Engineering (NDE) that comprises a selection of NQF registered unit standards designed to replace the old NZCE courses. These unit standards incorporate standards or competency-based assessment against the unit standard and require a student to meet specified conditions to gain the 12 credits for each unit. No information, other than the learning outcomes and performance criteria contained in the unit standard, was given to assist education providers.

The introduction of Unit Standards together with the listing of learning objectives and their performance criteria provided the opportunity to take a fresh look at assessment. The development of more interesting and challenging authentic assessment opportunities that would develop the characteristics and performance skills required of graduates by prospective employers, became a possibility. The biggest change and therefore the greatest opportunity, was the listing in the Unit Standards of the actual performance criteria using recognised behavioural objectives. Regrettably, the ETITO endorsed a request from the consortium of polytechnics that a national examination be established as part of the pass criteria even though the NDE courses incorporated unit standards that are registered as being standards-based assessed. The reason given was that an examination provided a means of moderation or keeping a ‘balance’ between the various providers assessing these unit standards. The format of the examination was carried over from the old NZCE programme and was set by an examiner appointed from teaching staff within the consortium.

As these unit standard courses were being developed and registered by the ETITO, the Institute of Technology for which I worked (referred to in this document as MYTEC), took the opportunity to develop and introduce their own local Diploma in Technology (Dip Tech) as part of its technician level programme structure. Arguments for this development of a local diploma was that it provided a much greater choice of courses for students to take to complete a diploma, while at the same time provide a pathway for students to leave MYTEC and continue studies at another training provider, or vice versa.

The courses that are offered for the first year of the electrotechnology option of the Dip Tech had to meet the MYTEC diploma criteria that each course has an equivalent value of 15 credits. To achieve this, the Dip Tech courses in the electrical and electronic related disciplines are a mix and match of the course contents of the original NZCE programme so that the four 15 credit performance-based Dip Tech courses subsumed five 12 credit standards-based NDE courses. Although the prescriptions for the Dip Tech courses are written in terms of learning outcomes and performance criteria, the format reflected that of the traditional written course content approach. These Dip Tech courses also retained achievement-based assessment where a mixture of coursework tests, assignments and a final examination are used to produce the required grade. Students enrolled at MYTEC in the Dip Tech courses primarily study for the local Dip Tech qualification, but because both the standards-based NDE and the performance-based Dip Tech at MYTEC are designed to replace the original NZCE prescriptions, students were allowed to work towards both qualifications at the same time.

The Dip Tech Curriculum Document (MYTEC) (Faculty of Applied Technology, 2002), provides criteria on assessment in the section, General Aim and Qualities of Assessment. These criteria include the need for assessment to be an integral part of the teaching and learning processes that are used to deliver the courses in the programme. Students are to be assessed according to the learning outcomes and performance criteria outlined for each course and assessments must aim to be a positive process enabling students to meet the learning outcomes of the programme. Criteria for the assessment methods are to be clearly identified, assessments will be appropriate, fair, reliable and manageable and, wherever possible, integrated with learning/work. Any evidence collected during assessment will be valid, direct, sufficient and authentic and the assessment judgements will be consistent, open and credible.

The stated system of assessment for the Dip Tech is 'Mixed Mode', combining both graded achievement-based assessment and competency-based assessment, thus requiring graded achievement results alongside unit standard performance criteria results. There was also the requirement that the proposed dates and schedules of assessments together with the specific nature and scope of requirements for assessments will be included in course detail documents provided to students at the start of each course. The Curriculum Document also clearly states that the tutor is responsible for assessment of students: "Tutors are responsible for ensuring these assessment qualities", and "The tutor delivering the course is responsible for assessments, scheduling of assessments, resits and result-reporting". Although a small minority of tutors had undertaken study in their own time that had covered assessment techniques, the majority of tutors have had little institute-provided professional development on assessment techniques, and little support was readily available.

The prescriptions detail the assessment requirements for each course and as an example, in the course 'Direct Current Circuits', assessment requirements are described as Mixed Mode where the achievement criteria consist of assignments and laboratories (20%), tests (20%) and examination (60%) of the total mark, and that the "students must meet the competency criteria of the unit standards as detailed in the competency assessment guide".

Although this scenario was unique to the MYTEC diploma, verbal feedback from other education providers indicated that they also were having difficulty in establishing an effective standards-based assessment regime. Consequently, the standards based NDE courses reverted back to performance-based assessment and a pass grade of 50% was used to indicate a competent 'pass' for the NDE. Teaching remained examination focused and little, if anything, changed in the way the assessment of courses was conducted. It is likely that the retention of the traditional examination that produced marks facilitated this reversion. Such an approach is thwarted with difficulties, not the least being the implication that attaining a 50% mark, an average over the required performance-based assessment, deemed a student to having met the requirement of being competent for each of the learning objectives in the associated unit standard.

Moderation of programmes and courses was done using tutors from other technical institutes or polytechnics, but in the main these moderators based their decisions and recommendations on their teaching experience rather than on professional teaching education. Moderation reports also tend to focus on aspects other than the moderation of assessment.

1.3 RATIONALE FOR THE STUDY

A major objective of this study was to develop an assessment framework to meet the achievement-based assessment requirements of the Dip Tech and the standards-based assessment requirements of the NDE. Such a framework should encompass equitable strategies (Parker & Rennie, 1998) and combine effective standards-based and achievement-based assessment (Angelo & Cross, 1988; Miller & Rutherford, 1996a, b), without subjecting students to an unpalatable assessment diet. An assessment framework should also consider the strategies outlined by the NZQA for use with the NQF and the assessment content should not become the driving force behind what is taught in the classroom (Popham, 1998).

To facilitate effective and meaningful assessment, other secondary questions arise when the overall learning environment of these diploma courses is considered. The national qualification for secondary school students was currently changing from the School Certificate, 6th Form Certificate and Bursary qualifications, to the three level National Certificate of Educational Achievement (NCEA). NCEA uses a credit-based measurement of achievement against standards administered by NZQA. Examinations can be used for regular school subjects and internal assessment used for those aspects of courses that cannot be tested in an examination. Over the years, new students entering tertiary education will increasingly have the NCEA based experience in secondary school learning and assessment.

Over the past decade there has been global awakening to the need to increase the skills level of the workforce. Australia conducted its own investigation into the trends and shortages of skills (Department of Employment Education Training and Youth Affairs, 1998) while New Zealand has reports emanating from government organisations about this concern (Maharey, 2001; Skill New Zealand, 2002). Although specific work skills are important, there has been an acknowledgement that other skills are necessary. A modern catchword for the basic level of these other skills is transferable skills as discussed by Dekker (1994). Other publications refer to these skills in a slightly different context, such as Gibbs, Rust, Jenkins, and Jaques (1994) who discuss the development of students' transferable skills and the OECD (1999) document that outlines an international framework for assessment of reading, mathematic and science literacy skills. In Australia, two significant research projects have been conducted. One was to establish a list of necessary skills (Department of Employment Education Training and Youth Affairs, 1998) and the other to determine employer satisfaction with graduate skills (Department of Education Training and Youth Affairs, 2000). In other countries (such as Canada) similar research has been undertaken. In New Zealand however, recent publications have identified the need for the development of a skills-based workforce (Kerr, 2002; Skill New Zealand, 2001), but these publications do not identify the actual skills required. Attempts to uncover similar research in New Zealand to that undertaken in Australia were not successful. Responses from NZQA, Department of Labour, Tertiary Education Commission, Ministry of Education, Industry Training Federation, Engineering Associates Registration Board, ElectroTechnology ITO and Skill New Zealand, all indicated that these organisations have no knowledge of a skills survey for a graduate technician. The Institute of Professional Engineers of New Zealand (IPENZ) has developed their own competency standards for engineering technicians seeking entry onto the IPENZ membership register of Engineering Associates (AIPENZ) but this does not necessarily match those skills required of graduates entering their first job. A media release in May 2002 (Institution of Engineers of Ireland, 2002), released the information that a major international agreement called the Dublin Accord was signed. This accord recognises the engineering technician academic programmes and the actual skills that will assist in the mobility of these qualifications. The Accord lists the desired theoretical skills required by a graduate technician but it does not consider the non-technical or transferable skills. Feedback from employers over many years suggests that it is important to train students so that when they leave tertiary education they have the skills to become a productive employee. Are these employee skills the same as those identified as transferable skills? Which skills are important to an employer? An unpublished report from the University of Waikato (circa 1991) gave an ordered list of the ten preferred attributes of a prospective graduate employee. Near the bottom was "theoretical knowledge" while above that and therefore rated as being more important, were items referring to abilities to work independently or in a group, taking responsibility for finishing a job, communication, etc. What are the specific skill attributes that graduate diploma students need to possess to maximise their prospect of employment and can this knowledge be used in the learning environment and in the development of the assessment framework?

Associated with the need to consider standards-based assessment is the opportunity to re-evaluate current practice and assessment procedures in the laboratory. Can the opportunity presented by the need to develop an assessment framework promote an improvement of the laboratory-learning environment and produce alternative strategies for the assessment of laboratory skills and processes?

Answers to these questions could provide knowledge and direction in either the refocusing and/or implementation of changes to create a learning and assessment environment more conducive to successful student outcomes.

Finally, an assessment framework should encompass both the learning and assessment environments of the student so that their educational, training and experiential elements of learning activity are integrated (Walklin, 1993), their experiences of previous learning are maximised and the opportunity to develop the skills required of a graduate employee are provided.

1.4 RESEARCH QUESTIONS

The general research question will enquire into the learning and assessment environment for the first year of a two-year electrical/electronics Diploma in Technology programme.

Specifically the study will:

a) Determine a prioritised list of skills desired by industrial employers of graduate technicians to either confirm or re-establish a benchmark for students' skill based learning outcomes and to consider this list of skills in the classroom environment and in the development of the assessment instruments within the assessment framework.

b) Conduct a grounded theory research into literature to develop a theoretical model of some of the inputs that impact on the teaching environment.

c) Investigate the development of a working model that incorporates a suitable assessment framework to meet the requirements of the local Diploma of Technology's achievement-based assessment while at the same time meeting the requirements of the National Diploma of Technology standards-based assessment.

d) Review the current practice in laboratory periods to promote an improvement of the learning environment and to investigate alternative strategies for the assessment of laboratory skills and processes to meet the assessment requirements.

e) Implement a trial of the working model and evaluate the specific attributes of that model that are the focus of this study.

1.5 SIGNIFICANCE

The primary reason for this study being significant is that it will provide an important assessment framework to overcome the present difficulties of how to assess students' learning of similar course content to produce a graded achievement mark, while at the same time check the students' competency against the requirements of the associated Unit Standard. The study will also provide information on the methodology involved in implementing an assessment framework for other courses requiring both achievement-based and standards-based assessment. Associated with the primary reason are three other reasons for this study to be significant. First it is likely to provide information to develop a focus for technician level programmes, both from an academic and a skills based perspective. Second it is likely to provide a greater understanding of the tertiary "science" laboratory environment and possible alternative strategies for the assessment of laboratory skills and processes. Third it is likely the combination of these will lead to a greater understanding of those factors which maximise a student's opportunity to gain learning outcomes that lead to employment.

1.6 OVERVIEW OF METHODS

The scope of the study was to research literature that has relevance to assessment in a particular education setting and to undertake research to determine the employer preferred skills of a graduate student. That information was then used to develop, implement and trial an assessment framework. Limitations of the study are multifaceted, mainly because of the necessity of keeping to parameters outside of the control of the teacher/researcher and a small sample size. The final design of the assessment is in itself a limitation in that it is accepted there would be other viable alternatives.

1.7 OVERVIEW OF THE THESIS

This chapter has outlined the background and scope of the significant problem of assessment peculiar to this context. The historical background serves to give an understanding of the development of the qualification over many years, yet there is no simple answer for much of the complication inherent in the present combined diploma structure. The reasons for a dual system of qualifications and their assessment requirements are outlined, as is the need for a survey of employers' requirements for skilled graduates.

Chapter 2 presents a review of literature taken from a broad spectrum of resources in order to capture an understanding of the findings of formal research and the experience of various education practitioners. This understanding would then provide a theoretical background to the study. Many arguments are presented that provide a network of structural support for the development of the theoretical model. Chapter 3 discusses the methodologies used in the various aspects of the study while Chapter 4 presents information, data and structure of a theoretical model of the learning environment. It also describes in part the procedures and material used in the research of the employer requirements of graduate skills and presents the results of the employer skill questionnaire.

Chapter 5 describes the process of disseminating the prescriptions and recombining the content to specifically produce a list of learning outcomes common to both assessment regimes, the developmental approach to establish the assessment scoring rubric and associated criteria, and an overview of the proposed framework. Chapter 6 presents an evaluation and reflection of the trial of the working model, discusses student feedback of the learning/assessment environment and their perception of the importance of skills, and an investigation of the reliability of the assessment-scoring rubric. Chapter 7 offers some reflections on the study, discusses suggestions for future research and draws the study to a conclusion.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

There has been and continues to be an abundance of literature on the relative merits of assessment, the different approaches to assessment, the determination of a student's learning through assessment, the importance of a supportive learning environment and the need to consider employability skills as a necessary part of the learning process. An important part of this review was to seek literature that would provide background to the questions raised in this research.

This chapter seeks to present a review of some of that literature relevant to the principles of assessment (Section 2.2), needs and concerns of assessment at the tertiary level (Section 2.3), background to and the need for considering employability skills as part of the learning experience (Section 2.4) and information regarding the situation in New Zealand (Section 2.5). Because the main focus of this research is in an engineering discipline, Section 2.6 focuses on literature more specific to engineering. Finally, Section 2.7 provides a summary of the literature and how it relates to the research questions.

2.2 ASSESSMENT

Education may be defined as a transformation process, a transformation of the student at the beginning of a course into the student with the desired characteristics at the end of the course. Whether or not this transformation was successful will generally be determined by the judgment of student learning (Rompelman, 2000). The process by which a judgement is made about the quality and worth of an individual student's work is usually described by the words evaluation and assessment. The formative and qualitative feedback offered to students and the ‘judgements’ made about the ‘process’ of learning is more commonly described as being evaluation, whereas the provision of summative feedback (a grade or percentage) to distinguish the quality of the product of learning is more commonly described as assessment (Hinett & Thomas, 1999). Because the terms assessment and evaluation are often used in a similar context, the term assessment will be used in this report.

2.2.1 Assessment Principles

Testing (assessment or evaluation) has been a necessary part of mankind’s society for as long as education or training of others has been part of the expansion of knowledge. In this concept, testing can refer to any form of measurement that could yield clear, consistent, meaningful data about a person’s knowledge, aptitudes, intelligence or other mental traits (Fischer & King, 1995). A test is an instrument used in assessment and assessment is the process of ‘sitting beside’ - a process of collecting and organising information or data to make it possible to ‘judge’ or evaluate a person (Chittenen, 1991).

Reasons for carrying out educational assessments include formative assessment that supports learning, summative assessment that produces grades or marks to certify individuals, and evaluative assessment that is used by educational institutions for accountability purposes (Wiliam, 2000b).

Norm-referenced assessment (also referred to as ‘grading on the curve’), seeks to place individuals into predetermined bands of achievements (Dunn, Parry, & Morgan, 2002) and measure and describe their achievement in comparative terms (Tan & Prosser, 2004). In other words, students compete for limited numbers of grades that range between fail and excellence. This approach to grading infers very little about the students’ learnt outcomes or about the nature or quality of teaching and learning. It speaks more to traditional and rather antiquated notions of ‘academic rigour’ and ‘maintaining standards’ (Dunn et al., 2002). Its effect is to rank order student achievement without reference to the individual student’s actual achievement and therefore causes students to think that their achievement is determined in terms of actual merit rather than relative merit (Tan & Prosser, 2004). “Norm-referenced testing, although I believed it had some sort of role to play in education, provided teachers with far too little practical guidance about how to devise their instruction. Moreover, I thought that norm-referenced test results yielded an altogether misleading picture of an instructional program’s effectiveness” (Popham, 1998, p. 383). The real problem with norm-referenced assessments is that it is very easy to place candidates in rank order, without having any clear idea of what they are being put in rank order of (Wiliam, 2000a).

Traditional assessment has focused on the differentiation and comparison between students over a whole course of study by testing everyone under standardised conditions. Marks from these assessments where everybody sits the same test within the same time limits, are added to indicate the relative success of each student. Marks are then probably ‘spread’ to meet the ‘norm’ (New Zealand Qualifications Authority, 2001). When the primary goal of students becomes ‘learning for the exam’, the assessment process will condition student study behaviour. If the examination remains unchanged, then even the modification of courses is unlikely to have much effect on study habits. As a consequence, examinations breed bad study habits (Khambadkone, 2001). Even the performance of students in an end of course examination can be affected when changes to the mode of in-course assessment does not enable students to remedy any learning deficiencies (Greer, 2001). The predictability of these assessments allows teachers and learners to focus on only what is assessed, and the high stakes attached to the results create an incentive to do so. This creates a vicious spiral in which only those aspects of learning that are easily measured are regarded as important, and even these narrow outcomes are not achieved as easily as they could be, or by as many learners, were assessment regarded as an integral part of teaching (Wiliam, 2000b). Because the learning of many students is organized around the assessment, a prospect of removing the examination from the assessment regime would most likely mean that many students would not put in the effort to learn the material (Greer, 2001). Experience in support of criterion-referenced assessment as a method of improving teaching quality leads to the conclusion that the traditional approach to measurement that most educators were using wasn't going to be very helpful as a way to improve the quality of teaching (Popham, 1998).

It is suggested that current assessment policies have gone from the use of assessment for learning (formative assessment) to the idea that educational assessment is primarily designed and used for selecting and certifying the achievement of individuals (summative assessment), and then tried to make these assessments also provide information with which educational institutions can be made accountable (evaluative assessment) (Wiliam, 2000b). Hence educational assessment has become divorced from learning and the original contribution that assessment made to learning has been largely lost (Wiliam, 2000b). Assessment should not simply be part of a system used to produce a mark or grade (summative assessment) but rather it should be an integral part of the learning environment and promote the enhancement of learning. Assessment is vitally important to students and because it exerts a major influence on their approach to learning, the assessment procedures that are implemented by the teacher should promote and reward the achievement of desired learning outcomes (Hargreaves, 1997). This means that all parties who influence the assessment procedures or outcomes (including institutional management who want assessment for accountability), must seek to ensure that their approach to student assessment is firstly for the benefit of student learning and not for other purposes. The incorrect approach to assessment and associated evaluation of student achievement has limited the learning opportunities of students (Kyle, 1997), and the tools or instruments of assessment can be interpreted by students as defining the main part of the subject area, what is important and where they should focus their time (Brown, Bull, & Pendlebury, 1997). In the book 'But...the curriculum' (Mamchur, 1992), there is a list of questions that teachers should ask themselves regarding power in the classroom. Questions such as 'how often do I allow students to have a choice in the classroom' and 'how am I helping students to be responsible for their own learning' focus on the student.

Rather than forcing a student to follow and work through the curriculum in a predefined order, students should be encouraged to be responsible for their learning and make choices where possible. In this way the curriculum is not just the sole function of the course, but it becomes a vehicle for learning (Mamchur, 1992). Learning should not simply be a quantitative change in the amount of knowledge someone possesses, but rather learning should be seen as a measurable change in the way a person conceptualises, understands, sees, and experiences something new in the real world (Marton & Ramsden, 1988).

While there is a need to integrate (or at least align) the routines of informal classroom assessment with more formal assessment practices (Wiliam, 2000a), it is pointless developing a curriculum that encourages a deep approach to learning if the assessment in turn encourages students to adopt a surface approach (Greer, 2001). Rather than simply being a means to an end and that end being principally the awarding of a grade, assessment should be seen as an important means of helping students to learn and to assist teachers and students realize their goals (Kyle, 1997). There are also many activities that occur in the learning environment that can assist or provide information that can be used in the process of assessing a student's performance. Traditionally, assessment has been derived from the curriculum; however, assessment has not been part of the feedback loop linked to instruction (Pandey, 1990). Consequently, traditional assessment tends to focus on whether students get the right answer and tends to ignore whether there is an understanding of the process of how the student arrives at the response (Fischer & King, 1995). The term 'traditional assessment' is established so firmly as being the provision of a benchmark of certification usually generated by the staff member, that any change in this term is very unlikely (Hinett & Thomas, 1999).

Assessment should be used to inform instructional process, contribute to the process of enhancing student-learning opportunities and be a means of providing opportunities for students to demonstrate how much they understand, instead of a means of getting a single score for comparative purposes (Hargreaves, 1997). However, there is a lack of evidence to support an argument that knowledge acquired as outcomes is even beneficial to the learning process (Kyle, 1997). There is a need for assessment to provide feedback to both teacher and student and then to be used to control further development of the curriculum (Gipps, 1990). There is a warning about the use of standardised tests used across a range of schools in order to produce some form of standardisation or level of performance (Boaler, 2003). The use of standardised tests can seriously disadvantage certain groups of students while at the same time advantage other groups, and the labels inferred by the tests can damage a students psychological understanding of their abilities. A curriculum that is both standardised and superficial limits learning opportunities for students (Kyle, 1997). Consequently there is a need for standards and not standardisation, the need for better assessment and not better testing, and a need for authenticity and validity (Freeman & Lewis, 1998; Wiggins, 1993).

When information from an assessment is used to improve student performance, that assessment can be considered formative assessment (Brookhart, 2001). This process of assessment improving student learning and performance is termed feedback, and for feedback to exist, the information about the gap must be used to alter the gap. If the information is not actually used in altering the gap, then there is no feedback (Wiliam, 2000a).

The role of assessment as a tool in the learning process cannot be undervalued and conventional assessment practices do not encourage lifelong learning, critical thinking or a deep understanding of subject matter (Hargreaves, 1997). Therefore students should be exposed to assessment that is a dynamic part of their learning process and see assessment as part of that learning (Kyle, 1997). The fundamental goal of teaching and learning mathematics should be to help students solve problems of everyday life and to prepare them for jobs, vocations, or professions. Such a goal suggests that as an example, school mathematics should diminish in the role of routine computation and instead focus instead on the conceptual insights and analytical skills that are at the heart of mathematics (Pandey, 1990).

2.2.2 Authentic Assessment

Performance assessments, such as performance tasks, projects, and exhibitions, are better suited than traditional tests to measure whether students can apply their knowledge, skills, and understanding in important, real-world contexts (McTighe, 1996). Elliot (1995) discusses performance-based assessment and suggests that this is a more practicable alternative to norm-referenced tests. This is an important advantage because sampling pupils' achievement by means of short exercises taken under the conditions of formal testing is fraught with dangers. It is now clear that performance in any task varies with the context in which it is presented, therefore our choice of assessment methods should be conditioned by our goals for student learning (Hargreaves, 1997). Thus some pupils who seem incompetent in tackling a problem under test conditions can look quite different in the more realistic conditions of an everyday encounter with an equivalent problem. Indeed, the conditions under which formal tests are taken threaten validity, because they are quite unlike those of everyday performance (Black & Wiliam, 1998).

Performance assessment is defined as a method of testing that requires students to create an answer or some product by which they have demonstrated their knowledge and skills (U.S. Congress Office of Technology Assessment, 1992). Into these methods of testing would fall conducting experiments, writing extended essays, doing mathematical computations, etc. Teachers using performance-based assessment can obtain a much richer and more complete picture of what students know and are able to do. Valid performance-based assessments should exhibit five internal characteristics: have meaning for students and teachers and motivate high performance, require the demonstration of complex cognition, exemplify current standards of content or subject matter quality, minimize the effects of ancillary skills that are irrelevant to the focus of assessment and possess explicit standards for rating or judgement (Elliot, 1995). When this approach to assessment requires students to be involved with problems or tasks similar to that in the discipline related work environment rather than answering questions out of context, it is generally referred to as authentic assessment.

Fischer and King (1995) define authentic assessment as an inclusive term for alternative assessment methods that examine students' ability to solve problems or perform tasks that closely resemble authentic situations. Pearson Education Development Group (n.d.) advocates that authentic assessment aims to evaluate students' abilities in 'real-world' contexts. In other words, students learn how to apply their skills to authentic tasks and projects. Chittenen (1991) discusses some of the terms relating to authentic assessment and suggest that authentic assessment requires new assessment practices rather than conventional practice, should be ongoing and cumulative rather than an annual event, should draw on a variety of settings rather than being based on a single setting and should be theory-referenced rather than norm-referenced. Assessment is authentic when students are directly examined on their performance on worthy intellectual tasks. Authentic assessment includes a wide variety of assessment methods developed to simulate 'real world' experiences where the students 'do' rather than the teacher does 'to' or 'for' them (Amos, 1998). Authentic forms of assessment include a wide variety of approaches that are designed to match as closely as possible the real world experiences that a graduate student could expect to find in their employment (Kerka, 1995). They present a more qualitative and valid alternative to traditional assessment, that by contrast, is not authentic when it relies on indirect or proxy 'items' (Wiggins, 1990).

Traditional assessment tends to rely on indirect or 'unreal' situations that offer simplistic substitutes that can often be rote learned (Wiggins, 1990), whereas authentic assessment does not encourage rote learning and passive test-taking (Pearson Education Development Group, n.d.). Authentic assessment focuses on students' analytical skills, their ability to integrate what they learn, creativity, ability to work collaboratively and written and oral expression skills. At the same time they promote ongoing assessment that is woven throughout the teaching and learning process (Amos, 1998). Students reply to tasks that require a demonstration of knowledge and skills and how the student responds and accomplishes the task are the important aspects of the assessment. This values the learning process as much as the finished product (Fischer & King, 1995; Pearson Education Development Group, n.d.). Authentic or alternative evaluation techniques of student learning can also be used to complement the more traditional pen and paper instruments (Fraser, 1996) and allows for the use of a variety of assessment instruments such as portfolios, self and peer assessment, individual and group projects, formal and informal observations, interviews, presentations, writing samples, etc. (Amos, 1998). If students are to improve their performance on assessments, there is a need to engage in performance-based instruction on a regular basis because increasing the use of performance assessments by itself will not significantly improve student performance (McTighe, 1996). Students who undergo transformation and integration tend to adopt a deep approach to learning and attempt to make sense of what they are trying to learn. They engage actively with the new knowledge and try to relate what they already know to other subjects and to the outside world (Hargreaves, 1997).

A summary of the comparisons between traditional and authentic assessment follows the argument that reforms in assessment should be seen as a means of driving assessment toward meeting the needs of students, not just a means of supposedly gathering scores to give what is generally assumed to be an assessment of a student's competence (Wiggins, 1990). Authentic assessment requires that students need to be effective performers with acquired knowledge demonstrating that they can produce thorough and justifiable answers, performances or products. Tasks are used to help students rehearse for the complex ambiguities of the adult and professional life by presenting the student with the full array of tasks that mirror the priorities and challenges found in the workplace. Validity depends in part upon whether the test simulates real-world 'tests' of ability.

Traditional assessment is usually limited to paper-and-pencil, one-answer questions where students typically only select or write 'correct responses' irrespective of reasons. Consequently tasks are more like drills, assessing static and too-often arbitrarily discrete or simplistic elements of the activities as students tend to reveal only whether they can recognize, recall or 'plug in' what was learned out of context. Validity is determined mainly by students producing a response that matches that of other tests. For this reason, a move from a traditional assessment program to an authentic assessment program requires not only a change in the assessment instruments, it also needs to investigate and discuss the changing beliefs and goals and to use these to redefine the goals and methods of instruction (Fischer & King, 1995). Roeber (1996) discusses time proven guidelines developed for use in training workshops for state and local educators. These are used to guide the process by which performance assessments can be created, validated, and used in large-scale assessment.

The term 'performance assessment' is used for those assessments that go beyond paper-and-pencil, group-administered assessments and which are an important and unique tool available for measuring student performance (Roeber, 1996). This means that the use of performance and authentic assessment does present challenges in that the teacher and student roles in the classroom are changed and they require putting aside previous notions about testing and evaluation (Kerka, 1995). However, authentic assessments do not necessarily have to replace traditional forms of evaluation but can be used to enlarge and broaden the picture of learner progress (Kerka, 1995)

In summary, a change to authentic assessment requires a change in assessment, curricula and instructional strategies, so that assessment reflects a performance orientation (McTighe, 1996). It involves a complicated re-evaluation of classroom practices (Zessoules & Gardner, 1991).

2.2.3 Assessment in the Learning Environment

The links between teaching, learning and assessment are so strong that it is impossible to disentangle or separate them (Hargreaves, 1997). There is also a growing consensus among many educators that the fundamental goals of teaching and learning are to help students develop the ability to solve problems of everyday life and to prepare them for jobs, vocations, or professions (Pandey, 1990). The California Mathematics Program involves four dimensions of the real-life approach to assessment; thinking and reasoning, working individually or in small groups, using symbols, tables, graphs, drawings, calculators, computers, and manipulatives, and a change in attitudes and dispositions (Pandey, 1990). The role of the teacher changes from that of a giver of information to one of facilitating the students' learning to use their knowledge to cope with unconventional problems. Such a change in the learning and assessment environment has many advantages. It requires a reconsideration of the overall plan and purposes of assessment, as well as knowing what students and teachers actually want and learn from the assessment efforts (Chittenen, 1991; Fischer & King, 1995). Assessments should be developed when it is necessary to check how well people can perform through the use of their skills and other observable behaviour, a demonstration of their understanding, knowledge, ability and learning (Peddie, 1992). An increase in knowledge and its subsequent recall is not a measure of learning, but rather learning is related to the understanding of fundamental principles and concepts which can be applied to both familiar and unfamiliar situations in the real world (Hargreaves, 1997).

The main function of a teacher is to create and manage a favourable environment for the student to learn and assess that learning process. Assessment of the learning process should be a case of finding out whether the student has met the objective or standard prescribed for that course of study. This becomes difficult if the learning objectives or learning outcomes are poorly written in the first place (Rompelman, 2000). Students tend to be assessed on those matters that are easy to assess and this in turn encourages them to focus on those topics that are being assessed at the expense of those which are not (Hargreaves, 1997). Assessment of classroom environment techniques is also an important approach in developing a learning environment that enables a student to arrive at an educational objective (Fraser, 1996).

Formative assessment has the advantage of providing feedback to students and to teachers during the term of a course of learning and therefore it is an essential component of the overall assessment plan of classroom work and of promoting the raising of standards of achievement (Black & Wiliam, 1998). However it is only when the student or learner is placed in the central role and when the information it provides is used for improving student performance, that assessment can be considered formative (Brookhart, 2001). Black and Wiliam (1998) take this further by suggesting that assessment becomes formative assessment only when the evidence is actually used to adapt the teaching to meet student needs. Therefore the terms 'formative' and 'summative' are descriptions of the use to which information arising from the assessments is put (Wiliam, 2000a).

Feedback generated by and for the students to help students understand the requirements of formal assessments is achieved through the process of self- and peer-assessment (Hinett & Thomas, 1999). Self-assessment is a form of formative assessment and can be an essential tool to enable students increase their ability to be an active participant in their own learning (Boud, 1995). Sluijsmans, Dochy, and Moerkerke (1998) describe self and peer assessment as fundamental for learning and there is a need to change assessment, including examinations, to incorporate these types of assessment to facilitate the learning process.

The essential foundation for effective formative assessment is a strategy that ensures the student has a clear concept of the learning goal, target or outcome, that the teacher's role is to ensure there is clear co-ordination and integration of assessment with classroom instruction, and where the teacher focuses on the student's performance through short-term feedback on individual assignments and through consideration of the varied set of data formed by ongoing student work (Brookhart, 2001). Firm evidence shows that formative assessment is an essential component of classroom work and that its development can raise standards of achievement. Therefore effective formative assessment is at the heart of effective teaching (Black & Wiliam, 1998).

In order that formative assessment will be effective, it is necessary for the teacher to know what feedback to give. This assumes that the teacher has an understanding of what causes errors in students' performance and how these errors can be minimised. Effective feedback is only as good as the information on which the feedback is based and this requires that the model of learning and of the assessment process and instruments are valid. Effective feedback also requires that the students know how to use feedback about their performance to compare and correct their developing conception of desired performance. For students to know how to effectively use formative feedback, they need to be taught how to monitor their own performance. Having students who are knowledgeable in this process is the ultimate goal of providing feedback (Brookhart, 2001).

Teachers must be involved in both formative and summative assessment, and keep them in balance. This does not mean that separate assessment instruments have to be developed as the same assessment might be used both formatively and summatively (Wiliam, 2000a). Formative assessment is focused on the needs of the student and is private to that student whereas external pressures and constraints, and the need for accountability from administration, can drive summative assessment. However, the ultimate responsibility for the guidance of students and the judgment of how successful the guidance has been is given to the teacher (Brookhart, 2001).

Another approach is the use of learner-centred instruction in college science and mathematics classrooms. This approach to learning instruction can achieve many positive outcomes in students and faculty alike. By placing more emphasis on improving the quality of day-to-day assessment practices, substantial difference in the achievement of students can be made. However, "faculty must be open-minded enough to consider ways of teaching that may differ radically from how they were taught or have taught in the past" (Walczyk & Ramsey, 2003, p. 579).

The development of a curriculum based on competencies where knowledge is a tool, rather than knowledge as simply a goal, is accelerated through strategies such as the use of self-, peer- and co-assessment used in combination with each other. These strategies then assist the development of a learning environment where the integration of instruction and assessment in higher education contributes to the education of responsible and reflective professionals (Sluijsmans et al., 1998). When assessment in used in a variety of integrated ways that does not separate formative assessment from summative assessment, students will be encouraged to engage in self-assessment as a regular, ongoing process and they will actively try to fit new information about their learning into their careers as students (Brookhart, 2001). If student performance is to be improved, they must have a concept of their learning goal, outcome or objective, a means of assessing their performance, the ability to compare actual performance with the desired performance, and the ability to act in such a way as to close the gap between the actual performance and the learning goal (Brookhart, 2001).

2.2.4 Assessment Validity and Reliability

Tests and examinations can be misused and these misuses include accepting that a title of a test is an accurate indicator for what the test measures, ignoring the error of measurement in test scores, and using a single test score for making decisions (Gardner, 1989). Assessment should conform to a set of basic principles; assessments should be valid, assessment decisions should be reliable, and the implementation of assessment instruments should make best use of human resources, physical resources and time (Scottish Qualifications Authority, 2001).

Popham (1998) discusses the need for teachers to know how to devise tests so they will become a potent tool in the hands of teachers and thus increase the benefit to students. He promotes the need for teachers to have clearly stated behavioural objectives for their classroom instruction so as to provide two key advantages – the students will know exactly what they need to do after each lesson and the teachers will be able to evaluate whether their instruction was effective. He concludes that small or narrow instructional objectives lead to teachers being overwhelmed with keeping records of individual objectives. The underlying comparative conception of the traditional norm-referenced assessment was not meaningful whereas criterion-referenced assessment provided specific goals that the student had to achieve. Thus assessment tests should be designed to provide teachers with a tool to clarify and enhance the instructional content of their lessons.

Validity may be described as a form of truth seeking, of matching the intention of the measurement with what was actually measured. The intrinsic validity of the assessment procedures is greater when the match between the objectives of the assessment and the actual assessment tasks is closer (Brown et al., 1997). The greater the ability of the assessment tasks to measure the underlying theory on which the assessment is based, the greater the construct validity. The greater the comparison between the results of an assessment task with those obtained on other assessments of known standard by similar groups of students, the greater the criterion validity. A test can be considered valid if the results accurately demonstrate the student's capability in achieving what the test set out to do. This is unfortunate, because a test could be considered valid irrespective of whether the test has anything to do with the learning objectives. In the wider sense, a test or any piece of assessment should only be valid when the assessment sets out to assess the learning objective, and the test results reflect the understanding of that objective. High content validity therefore can only be achieved when the test or assessment fairly and faithfully reflects and assesses the learning the unit or prescription is aimed at producing.

To do this, these must be a clearly stated set of learning outcomes and the associated performance criteria that will reflect the objectives of the whole of the course (Peddie, 1992). The degree of match between test content and the subject area content is referred to as alignment. In order to defend decisions based on student academic achievement, assessment must be aligned to the academic standards (La Marca, 2001). Validity expresses the appropriateness of the purpose of the test instrument, the degree to which evidence of a candidate's performance can be measured against standards, and the facilitation of reliable assessment decisions by all assessors for all candidates (Scottish Qualifications Authority, 2001). Validity is the extent to which a test accurately measures the objective(s) it was designed to test (Swezey, 1981) and the focus should be more concerned with the broader issue of the validity of the interpretation and use of an assessment outcome than the validity of an individual assessment instrument (National Centre for Vocational Education Research, 2001c).

Validity and reliability are shown to exist in engineering literature, although there is a need for engineering educators to better understand these terms (Moskal, Leydens, & Pavelich, 2002). The understanding of the two key measurement concepts, validity and reliability, are expanded by the writers together with an explanation of how these concepts can be used to improve assessment efforts in engineering education. Validity refers to the degree to which evidence supports the appropriateness of an assessment instrument for a specified assessment use. Four types of evidence are commonly examined to support the validity of an assessment instrument: content-related evidence, construct-related evidence, criterion-related evidence and consequence-related evidence (Moskal et al., 2002). Validity that focuses on a more 'integrated' or holistic view of assessment is better than addressing small individual components and as such should be considered one of the key pillars of any high quality assessment system (National Centre for Vocational Education Research, 2001c).

Reliability expresses the ability of valid assessments to generate consistent assessment decisions over time when the applied conditions of assessment remain consistent and when assessed by a range of assessors applying the assessment in different situations (Scottish Qualifications Authority, 2001). The major threat to reliability is the lack of consistency of an individual assessor and the consistency of a marker is more important than whether disagreement occurs with another marker (Brown et al., 1997). Practicability expresses the flexibility by which an assessment system can meet the needs of all candidates (Scottish Qualifications Authority, 2001).

Besides issues such as validity and reliability, assessment should also be fair and equitable, especially when different ethnic and gender groups are involved. For example, the traditional approach to assessment tends to favour males more than females because the assessment involved forms of knowledge more readily acquired by males (Parker & Rennie, 1998). Because the issues surrounding fair and equitable assessment are complex, it is unlikely that a fair test could be produced, the situation is too complex and the notion simplistic (Gipps & Murphy, 1994). However, three requisites that will assist in producing fair and equitable assessment are curriculum fidelity, diversity and opportunity, and values and ethics (Parker & Rennie, 1998). By applying these requisites and having some understanding about the effects assessment has on different ethnic and gender groups, it should be possible for a teacher to produce tests that move towards those that are more fair for the groups undertaking those tests (Gipps & Murphy, 1994).

2.2.5 Criterion-Referenced Assessment

"The terms 'norm-referenced' and 'criterion-referenced' refer to the type of test or examination, while the terms 'summative', formative' and 'diagnostic' refer to the function of assessment or examination" (Brown et al., 1997; Reeves, 2002). Fraser (1996) defines norm-referenced tests as a basis for comparing examinees with each other whereas criterion-referenced tests allow interpretation of performance in terms of defined competencies.

It was a desire for greater clarity about the relationship between the assessment and what it represented that led to the development of criterion-referenced assessments (Wiliam, 2000a). Standards-based assessment, standards-referenced assessment or criterion-referenced assessment may be described as the process of focusing attention on the explicit specification set by the standards because they set the clear descriptions of standards of performance, they inform students what they are expected to learn and how they should perform in their assessed work. Standards allow the development of shared understandings between student and teacher regarding the interpretation of these standards, and they inform teachers how to assess students accordingly through the use of teachers' qualitative judgements (Tan & Prosser, 2004). The essential key of criterion-referenced assessment is that the sphere of interest to which inferences are to be made is specified with great precision (Wiliam, 2000a).

Criterion-referenced assessment is being adopted as a more accountable assessment regime than norm-referenced assessment, because the quality of achievement is dependent on how well the student has performed as measured against specific criteria and standards (Dunn et al., 2002). The standard or the measure of a student's achievement is interpreted in terms of a clearly defined and delimited learning task (Tan & Prosser, 2004). However an underlying resolve to develop a criterion- or competency-based curriculum is the premise that knowledge is not a skill that is imparted from teacher to student, but a subjective skill that has to be acquired by every student (Tillema, Kessels, & Meijers, 2000). The purpose of Unit Standards is to make learning targets explicit so that learners are required to meet the standard in full before they get credit (New Zealand Qualifications Authority, 2001).

Assessment against an imposed criterion or performance standard provides a means to determine the extent to which a student can meet the specified criteria (Swezey, 1981). The items for a criterion-referenced test would be based on known performance objectives, absolute values or standards and the primary reason for using the test would be to measure mastery, i.e. whether the student has mastered the specified tasks or criteria. Competency-based or criterion-referenced assessment should be integrated to take less time, avoid over assessment and improve motivation, facilitate moderation, give assurance of overall competence and improve validity, and benefit the teaching/learning process (Scottish Qualifications Authority, 2001). Provided all outcomes are covered with the assessment instruments and marking instruments, there is no need to look for evidence against individual performance criteria. The aim should be to confidently determine that a satisfactory level of competence has been attained and allow normally one, or in exceptional circumstances two, re-assessment opportunities (Scottish Qualifications Authority, 2001).

A useful compromise between 'criterion-referenced' and 'norm-referenced' assessment is the use of a criteria-graded assessment in which the broad criteria for each grade level is specified. However criterion-referenced assessment in turn can be misused when grading is applied (e.g., a merit/pass/fail), since an assumption is made that high level of performance is a reliable predictor of future success (Brown et al., 1997).

As part of the current evolution of assessment, prescriptions are giving rise to well-defined behavioural objectives, learning objectives or learning outcomes that in turn are used as a guide for assessment tasks. Articles such as Kizlik (2003) and Kizlik (2004b) contain lists of verbs and suggested meanings that can be used to promote the writing and interpretation of well-defined behavioural objectives. Learning outcomes are not necessarily tied to specific performance criteria and may be used to explore other aspects of the learning process (Brown et al., 1997). Behavioural objectives in the context of assessment are not written for the curriculum, but need to be written to communicate to the student what is required and what they are to be assessed on. Well written objectives are required to focus the teacher on the lesson plan and hence promote learning, otherwise lessons can become flawed and the outcome difficult if not impossible to assess (Kizlik, 2004a, c).

The objective of criterion-referenced assessment is to determine if students can meet certain specified performance criteria for their performance tasks (Tan & Prosser, 2004). “In a competency-based curriculum, the content is not the central issue, but the assessment of the acquired skills” (Tillema et al., 2000, p. 266). In New Zealand, assessment to ascertain whether or not students have achieved the level of performance required by a unit standard is the purpose of assessment for the Qualifications Framework (New Zealand Qualifications Authority, 2001).

An assessment plan can be developed and implemented once the educational goals have been defined. These plans usually contain a statement of the educational goals and a selection of different measures of achievement of the goals. Part of this plan should include a feedback loop as a means of using the resulting information to improve both the education process of the student and the learning environment. In this way, outcomes assessment can be used to determine whether students have learned, have retained, and can apply what they have been taught as well as providing remedial action that could be taken to ensure that students do not graduate until a minimum level of competency is achieved (Shaeiwitz, 1996). Competency-based assessment can and should be carried out as a cyclic process as part of the learning cycle (Miller & Rutherford, 1996b). Assessment could be used to indicate whether more student directed and practice orientated learning does in fact occur, together with the better preparation of students for later work through competence-based curricula (Tillema et al., 2000).

"Behavioral objectives, all by themselves, were turning out to be little more than curricular rhetoric. Without assessment instruments to determine whether the objectives had actually been achieved, the instructional impact of even behaviorally stated instructional objectives was decisively underwhelming" (Popham, 1998, p. 382). In particular, it was hoped that performance domains could be specified so precisely that items for assessing the domain could be generated automatically and without disagreement (Wiliam, 2000a). Assessment results for the Qualifications Framework are aimed at describing the level of performance achieved in separate aspects of skills, knowledge and understanding. There is neither credit for partial success or failure, nor an attempt to produce a single global result for a whole course of study (New Zealand Qualifications Authority, 2001).

The focus of criterion referencing is in the greater transparency of the descriptors it gives for the abilities and achievements of learners and of the marking of their performance. However, while criterion referencing gives the impression that marking and grading against explicit criteria and standards is a relatively simple concept, it is complex conceptually and involves a range of problematic assumptions (Dunn et al., 2002). There are several questions that need to be answered about how standards-based education affects classroom instruction and assessment. The questions include where will the standards come from, who will set the standards, what types of standards should be included, in what format will the standards be written, at what levels will benchmarks be written, how should benchmarks and standards be assessed, how will student progress be reported, and what will the students be held accountable for (Marzano, 1996)? "We know much less than we wish we did about how competencies are acquired, and even less about how they can be taught" (Kearns, 2001, p. 55). Competency-based curricula does however require assessment approaches that are adapted and suited for competencies, and which are specifically tuned to evaluate competencies and not just content. “Therefore, it is essential to design and establish ways of integrating assessment with instruction in vocational education and evaluate their utilisation in institutions” (Tillema et al., 2000, p. 267).

Although the purpose of assessment under the Qualifications Framework is for credit on the Framework, other uses of the results is entirely up to an individual institution. For example, Framework results could be aggregated to produce rankings or whole-course results or to produce marks or grades for local reporting and awards (New Zealand Qualifications Authority, 2001).

The change from the traditional assessment regime to a competency-based or criterion-based assessment regime is not easy. An HOD summed up the change to the competency-based unit standards in a Scottish institution of higher learning as the problem was not in the Unit Standards, but in getting the teaching staff to change their traditional ways of teaching and assessment. The reasons are varied and ‘why change the assessment system’, ‘we’ve already tried that’, are just two of many reasons why teachers resist changes in assessment (Brown et al., 1997). This resistance to change and the stages teachers have to work through to change their teaching and assessment techniques is compared with the five stages of grief after learning of impending death (e.g., from cancer) (Feisel, 1998). For a teacher not used to change, and as is common in higher education, a ‘teacher’ who is a professional in their discipline yet an untrained teacher, the change can be a frightening and horrendous task.

2.2.6 Grading Competency-Based Assessment

In a paper that draws on the results of two projects to discuss competency-based training and in particular, concerns about assessment and the issue of consistency in assessment judgements (Booth, 2000), the writer summarises issues that consistently emerged for those who those involved in assessment practice. Two of these issues are the need to assess knowledge as well as skills, and the desire for grading of results. The solutions included the requirement that competency standards should adequately reflect the need for assessment to include the knowledge, skills, attitudes and ethics that form the base structure of the higher-level competency and include strategies to bridge the gap between competency and excellence. ‘Putting assessment into practice’ gives practical advice on the processes or methods of competency-based assessment (Miller & Rutherford, 1996b). The National Centre for Vocational Education Research (2002) suggest three reasons why many people find grading information valuable and therefore why a competency-based assessment grading system is required. Employers want better information to help them make better decisions about employing people, students want their level of work and achievements recognised, and teachers want a ‘carrot’ to encourage their students’ learning. The significant issue in criterion-referenced assessment however is that the pass/fail point is the important measure, not the ability to measure and describe students’ achievement in terms of different grades (Tan & Prosser, 2004).

Graded assessment was seen as a way to provide a means of identifying achievement and to motivate employees/learners. There is however several issues associated with grading within a competency-based assessment program. These issues can be summarised in that although there are several stated purposes or advantages of grading the assessment, there are no listed disadvantages. Arguments against the use of grading cover such aspects as premature use, inappropriateness, and against the principles of competency-based assessment (Thomson, Mathers, & Quirk, 1996). However research on these arguments against grading competency-based assessment should be encouraged, provided they are thoroughly researched and the results reported (Thomson et al., 1996). In another report resulting from a study into grading competency-based assessment procedures (Tan & Prosser, 2004), the argument is presented that teachers understand and use grades in different ways. Grade descriptors can be ‘generic descriptors’ (depicting achievement levels as descriptions of standards), ‘grade distributors’ (focusing on how students’ work can be understood in terms of how they are distributed amongst different levels of achievement), ‘grade indicators’ (they indicate to staff and students what a piece of student’s work might mean in terms of specific criteria) and ‘grade interpreters’ (they are perceived as authentic bodies of intrinsic meaning as to what actual achievement levels are). Employers do care that when students enter the work force, they are able to apply the knowledge they have learnt (Gfroerer, 2000), so performance standards should not only indicate a skill attainment but also require a knowledge and understanding in a variety of contexts so as to provide a link between what a student knows and is able to do.

A study undertaken by Williams and Bateman (2003) of graded competency-based assessment in the Vocational Education and Training (VET) environment in the Australian national training system, revealed that graded assessment was not fully understood nor universally implemented across the national training system. A majority of respondents also indicated that the need for graded assessment and consistency in graded assessment across national qualifications, were important considerations (Williams & Bateman, 2003). Running both a graded and non-graded assessment system may become administratively complex and costly, and professional development must be provided for those wishing to develop grading systems (National Centre for Vocational Education Research, 2002)

Although grading in a competency-based system is a contentious issue, it is a means of demonstrating a level of knowledge understanding that can assist in providing a link between the degree of a student's ability and their competency. There are however three preliminary criteria that need to be satisfied before attempting to grade a competency- based or standards-based system. The standards must embody the desired skills and knowledge that the students are to have, teachers must consistently use standards to guide their classroom instruction and assessments must be aligned with the standards and instruction (Colby, 1999). Unless assessments align to specific standards, the transition to standards-based grading system will be difficult (Colby, 1999). Competency, therefore, must be viewed as more than a series of checks against a list of competencies and include the requirement to demonstrate competence in a variety of ways (Gfroerer, 2000).

Issues surrounding the grading of competency-based assessment are complex and include suggestions that grading should be criterion referenced in a similar manner to competency-based assessment. Grading should also be discretionary and not compulsory, and be determined after the learner is judged competent and a minimum acceptable performance level has been achieved. Systems for grading need to be transparent and complementary to the already accepted assessment principles such as validity, reliability, flexibility and fairness (National Centre for Vocational Education Research, 2002). Although grading strategies are usually highly individualized, there are some other basic rules such as accuracy, consistency and defensibility. One key to producing defensible grading strategies is to select appropriate grading components and the weighting of those components (Ory & Ryan, 1993). They also present twelve activities for classroom testing and grading. However, the focus on grading should be to ascertain whether students can apply what they have learned as well as understand the theoretical principles involved. The use of examples to describe to students work that would merit different grades would assist in the process of identifying and resolving their different expectations of grade descriptors (Tan & Prosser, 2004).

Although many suggest a competency-based assessment grading system is required, there are few policies and guidelines that can be used to assist providers to implement graded assessment in a valid and consistent way (National Centre for Vocational Education Research, 2002). However faculty in an Illinois university have developed a list of suggested grading guidelines. These cover aspects such as; grades should conform to the institutional practices, grading should yield accurate information, grading plans should be communicated to students at the beginning of each semester and not changed if possible and the number of grading components should produce high accuracy (Office of Instructional Resources, 1979).

2.2.7 Assessment for Learning

Students should be given the opportunity to choose the assessment type they prefer out of an accepted range of types in order to improve the perceived reliability of the test and increase the motivation of the student (Birenbaum, 1997). Empowerment for a student in a learning environment should encourage self and peer assessment, enable them to feel free to critique the assessment practice and procedure and to be able to negotiate different practices from those proposed by the teacher (Leach, Neutze, & Zepke, 2001). The typical or traditional approach to assessment supports the authority of the teacher in the assessment process. Student empowerment on the other hand takes the power over the assessment process away from the teacher and distributes it between student and teacher. Operational knowledge is that knowledge associated with competency-based assessment (i.e. that which requires assessing against a predefined checklist), while academic knowledge requires learners to reproduce knowledge. Empowerment cannot be promoted in a system where the modes of assessment are dictated by the curriculum and the environment in which the whole program operates. Assessment will always lead to learning of some kind, but so often it is not what teachers actually want for their students (Hargreaves, 1997).

Assessment for learning is the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there (Assessment Reform Group, 2002). In the drive for the best possible education for all students, performance-based assessments can be used to improve student and teacher competency standards. In order to do this however, teachers need changes in their profession and in the education systems in which they work (Higuchi, 1993) and a new way of looking at knowledge requires new methods of assessment (Gfroerer, 2000). A review of research into classroom assessment (Black & Wiliam, 1998), has shown that formative assessment used as assessment for learning raises standards, that there is room for improvement in the use of formative assessment, and there are ways to improve formative assessment.

Reform from the traditional assessment environment to a successful standards-based environment depends on clear standards, well-crafted tests, and fair accountability (Gandal & Vranek, 2001). Several strategies can help teachers put these critical pieces in place. Standards must be teachable in order for them to have an impact on what goes on in the classroom. They must have clarity and encompass the principle that learning objectives are usually connected and they relate in the simplest or most economical way. Tests must measure the standards and if it is not in the standards, it should not be in the test. Tests should be rich and rigorous tests and become more challenging in each succeeding grade (Gandal & Vranek, 2001). These approaches will overcome any potential problem with the reliability and validity of assessment while allowing room for student negotiation of their own assessment.

In the modern science and technology society, a different type of knowledge is needed to that of a generation ago. Undergraduate education in engineering, science and mathematics has by tradition emphasized training in skills and assessment through an examination that often consisted of individually solved problems. Besides promoting shallow learning, students who perform well in examinations retain fundamental misconceptions about key concepts in the subjects they have passed (Hargreaves, 1997). Traditional examinations can actually inhibit the development of the students' independence and creativity (Berglund, Daniels, Hedenborg, & Tengstrand, 1998), through the discouragement of analytical and judgemental skills, as well as communication skills. It is also difficult to assess a student's reasoning skills because of the difficulty to set complex and/or loosely defined problems. The negative aspects of assessment inherent in many practices should be phased out and replaced with assessment that supports the teaching and learning processes (Hargreaves, 1997).

Changing the assessment method to suit the needs of the modern society through a change in the learning environment is also a way to make students reflect more on their studies and to apply more creativity and communication skills. Students need to be receptive to new skills and ideas other than just academic learning. These essential skills need new forms of assessment that in turn requires a new and different learning environment (Berglund et al., 1998). Learning needs to be an experience where authentic problems are worked through until an answer is found and one of the most powerful ways of improving students' learning and raising their standards is when assessment is used for learning (Black & Wiliam, 1998).

Assessment of learning usually has well established procedures set by 'authorities' outside of the classroom and more often than not, such assessment becomes an act of compliance, not a procedure to help students learn. Assessment for learning is more of a decision by the teacher to include suitable assessment within the teaching or lesson plans. Such a decision requires that teachers themselves have learned the principles to be put into practice so that the potential benefits are to be gained. The Assessment Reform Group (ARG) produced a leaflet that sets out 10 research-based principles of assessment that includes principles such as 'is part of effective planning', 'is central to classroom practice' and 'helps learners know how to improve' (Assessment Reform Group, 2002). Of particular importance is the principle that assessment for learning as a key professional skill for teachers, should be developed through initial and continuing professional development (Assessment Reform Group, 2002).

The consequences of changes to assessment practice may be that some elements of the current course prescriptions will be left out and certain academic skills will no longer be taught. Traditional examinations can still be used to assess the students' academic knowledge, which will in some respects be less, but they will receive other skills that are more relevant to present-day society (Berglund et al., 1998).

2.2.8 The Rubric for Scoring Assessments

Traditionally, educators have kept their assessment criteria and standards to themselves (Andrade, 2000). They often expect students to just know what makes a good essay, a good drawing, or a good science project, and the standards for their work have not always been clearly articulated for them. One way of assisting in the process of assigning multiple scores is to use marking rubrics (Marzano, 2000). A marking rubric (also called a scoring or instructional rubric) is described as being a descriptive scoring scheme that is developed by teachers or other evaluators to guide the analysis of the products or processes of a student's effort (Brookhart, 1999). They are designed to make performance criteria very clear, objective and simple in order to identify and clarify the important performance outcomes and to minimize guesswork by both teacher and student. The top level of a rubric will communicate what exemplary work should look like and this promotes the involvement of the student in constructive learning and self-evaluation (Hafner & Hafner, 2003). The use of rubrics will encourage students to develop self-assessment awareness in order to continuously assess their performance, direct attention to weaknesses, and promote formative feedback for improving performance (Amos, 1998). The inclusion of the rubric into the assessment process adds a different dimension by also providing the student with a self-assessment tool (Hafner & Hafner, 2003). Marking rubrics are typically used when a judgement of quality is required and they may be used to evaluate a broad range of subjects and activities (Moskal, 2000). They provide a description of various levels of performance and mastery for a performance task (Hafner & Hafner, 2003). They are easy to use and to explain, they make sense to people at a glance, and they make teachers' expectations very clear (Andrade, 2000).

Because rubrics specify the attainment criteria for a variety of topics or target areas, they help students understand the grades that have been assigned by their teachers and help make the process of assessing student work quicker and more efficient (Andrade, 2000). The use of a scoring rubric does not depend on the grade level or subject, but rather on the purpose of the assessment. A different type of scoring rubric may be designed for the evaluation of a specific task (analytic) or the evaluation of a broader range of tasks (holistic) (Moskal, 2000). Marking rubrics are especially useful in assessment for learning because they contain qualitative descriptions of performance criteria that work well within the process of formative evaluation (Tierney & Marielle, 2004). The performance criteria in rubrics are often designed to represent broad learning targets and this increases the universality of the rubric's application (Tierney & Marielle, 2004). Rubrics provide students with more useful feedback of their strengths and areas in need of improvement than traditional forms of assessment do (Andrade, 2000). They are valuable to both the teacher and the student as a quick and clear summary of performance levels across a scoring scale (Hafner & Hafner, 2003). The use of a marking rubric will soften the division between instruction and assessment and provide a teaching tool that will enhance student learning and the development of highly developed thinking skills (Andrade, 2000). They also play an important part of helping students understand how to construct their own learning and as a result of that, continue to be life-long learners (Hafner & Hafner, 2003).

Even though the rubric has become a popular assessment tool, until Hafner and Hafner (2003) undertook a study focussing on the validity and reliability of the rubric as an assessment tool, there was little information in the literature quantifying the actual effectiveness of the rubric (Hafner & Hafner, 2003). A quantitative analysis of the rubric used in their study shows that it can be used consistently by both students and the instructor and that the rubric appears to be 'gender neutral'. A significant, one-to-one relationship between the students' rating and instructor's rating was demonstrated across all years using the rubric (Hafner & Hafner, 2003). Neither did the students' academic strength seem to have any significant relevancy on the way that the rubric is used.

Because validity and reliability are not dependent upon the type of rubric, carefully designed analytic, holistic, task specific, and general scoring rubrics have the potential to produce valid and reliable results (Moskal & Leydens, 2000). When all the results are considered, the data indicates that the general form and evaluative criteria of the rubric is clear and that for peer-, group- and self-assessment by students, the rubric is a useful assessment tool (Hafner & Hafner, 2003).

Rust, Price, and O'Donovan (2003) present a paper that reports the findings of a two-year research project focused on developing students' understanding of assessment criteria and the assessment process through the use of a comprehensive marking criteria grid to help establish common standards of marking and grading. "The conclusions drawn from the evidence are that student learning can be improved significantly through such an intervention, and that this improvement may last over time and be transferable, at least within similar contexts" (Rust, Price, & O'Donovan, 2003, p. 147).

2.3 EMPLOYABILITY SKILLS

Over the years there has been a subtle but ever increasing change in the way employers and society in general measure the competency and expertise in the work environment. The traditional concept of cramming a student with knowledge with the hope that they can apply it in a work situation is not enough in today's workforce. In that traditional environment, the term 'employability skills' referred to those trained skills (academic or practical) required to acquire and retain a job. We are now being measured by a new standard, one which employers expect employees to be able to work independently and in a team, to be able to communicate effectively and one in which employees demonstrate an ongoing ability to learn on the job (Goleman, 1998).

A study in the UK has identified that over the past 30 years there has been an increase in the demand of generic skills and a shift in skills from those of manual work to those connected to cognitive abilities (National Centre for Vocational Education Research, 2000). "The demand for specific vocational skills is giving way to a growing need for generic cognitive skills—mathematical and verbal reasoning ability as well as a new set of general behavioural skills" (Kearns, 2001, p. 5). "Skills such as problem solving, communications, interpersonal skills and critical and independent thinking should be fostered in engineering, not just because they are qualities that employers look for but because they should be part of any tertiary education" (Beder, 2000 p. 46). These are the type of skills that act as the necessary prerequisites to enable people to participate in a society where the most important value added processes are not physical labour and routine tasks, but through information and knowledge (Tillema et al., 2000). Learning a skill means more than having an ability to do something, it means being able to do something because you have actually practiced it and demonstrated that you can do it (Dekker, 1994).

The type of knowledge needed by today's employers is one of personal competencies that include the ability to identify and solve new problems in the future that are not known today (Tillema et al., 2000). In terms of graduates being successful in job-hunting, the skills that most sets apart the successful from unsuccessful applicants in the pursuit of a job is the capacity for independent and critical thinking (Beder, 2000). The problem in New Zealand (as it is elsewhere) is that even when there has been strong uptake of structured industry training, some firms are finding it hard to recruit people with the right basic skills and attitude to support further training. A further difficulty is that economy-wide shortages have resulted in a restricted supply of skilled workers in some sectors (Maharey, 2001).

A two-stage research project in Australia to establish the extent of employer satisfaction with the skills of new graduates entering the labour market reported that the greatest skill deficiencies were creativity and flair, oral business communications and problem solving (Department of Education Training and Youth Affairs, 2000). Unsuccessful job applicants who lacked these basic skills were also much more likely to lack the capacity for independent and critical thinking, yet it is this skill that are of great importance to employers – "employers value this skill and can find it, but it is rare" (Department of Education Training and Youth Affairs, 2000, p. viii). Engineering graduates in particular were perceived to be poor at problem solving and oral business communications which employers consider important (Department of Education Training and Youth Affairs, 2000). "It is no longer sufficient, nor even practical, to attempt to cram students full of technical knowledge in the hope that it will enable them to do whatever engineering task required of them throughout their careers" (Beder, 2000, p. 46).

The debate on key employability skills has mostly been stimulated and led by individual employers and employer groups who are saying that although the broad objectives of the education and training systems are largely consistent with the skills requirements of industry (Curtis & McKenzie, 2001), being smart or being competent in our training is not enough. Emotional intelligence, the possession of these non-educational skills that are sometimes called soft skills, employability skills or transferable skills, are the types of skills that have traditionally been learnt over the years in the workplace. In the modern workplace, the definition of employability skills has been widened to include a variety of attitudes and habits as well as the many foundational academic skills (Saterfiel & McLarty, 1995). The term ‘employability skills’ has evolved to include the foundation skills that need to be taught to provide the foundation on which the skills for a specific job are built. Foundational skills include those that relate to communication (oral and written), personal and interpersonal relationships and the ability to solve problems (Lankard, 1990). There is however a lack of a common understanding regarding the area of skills and this is particularly reflected in the language being used. For example, adjectives such as core, key, generic and essential are variously used to preface nouns such as skills, competencies, capabilities and attributes. There is a need for a more common terminology in order that educators can work together with business more productively, and to learn from each other (Curtis & McKenzie, 2001).

Skills are an expression of talents, interests and personal qualities, developed through training or a natural ability. The level of competence that is reached in a particular skill is influenced by the natural ability that we have. A skill however is more than just the ability to do something. It means having the ability to do something because it has been practiced and preferably demonstrated to others in a direct or indirect way. The basic range of skills required for almost any job or activity can be classified as transferable skills because they can be transferred or adapted to different occupations (Dekker, 1994). Key employability skills are a means of providing a bridge between education and work and by providing the means by which workers can learn the ever-changing needs of a dynamic knowledge-based economy. The important aspect of this bridge is in its capacity to continually adapt and upgrade through key or generic skills that can be applied in different settings (Curtis & McKenzie, 2001).

Following the published report on Employer Satisfaction with Graduate Skills (Department of Education Training and Youth Affairs, 2000), an article was published in the Engineers Australia saying, “Its official: graduates are leaving university without essential skills that are not only demanded by employers but also crucial for good citizenship and social responsibility. The problem is particularly acute for engineering graduates” (Beder, 2000, p. 46). The article puts forward the argument that skills such as problem solving, communications, interpersonal skills and critical and independent thinking should be fostered in engineering education. In today's society it is no longer acceptable to cram a student full of technical knowledge. Tertiary education needs to develop courses that foster skills relevant to acquiring knowledge and develop abilities that allow people to cope with the uncertainty and change of the modern society (Standen, McKenna, & Williams, 1998). If employability skills were to be incorporated into a training programme, then there would be a need to develop assessment for skill areas other than traditional knowledge. It is not enough to drop a little from a conventional curricula lecture program in order to fit in some time for skills because the real challenge is that curricula need to be transformed if skills development is to be worthwhile (Gibbs et al., 1994).

In order to prepare young adults for tertiary education and the work place, they need not only have a good general education, they need to know about potential careers, have some familiarity with the world of the workplace and have developed a range of occupational competencies or employability skills. In the American Youth Policy Forum publication (American Youth Policy Forum, 2003), concern is expressed that "many high schools do not prepare their students well for the challenges of the global labour market" (American Youth Policy Forum, 2003, p. 1). "Attention on improved academic outcomes in a limited number of core competencies has meant little attention has been paid to how best expand the range of expected outcomes that include other valued skills, such as communication, teamwork, analytical, and interpersonal skills, that youth also need to be successful" (American Youth Policy Forum, 2003, p. 1). Education and training for future employment are intertwined and an imbalance of these two views is harmful to industry and society and a well-balanced education should embrace the ability to cope with everyday life, exercise creative skills, complete tasks and do things in co-operation with others (Stephenson & Weil, 1992). "Fostering generic skills requires active learning strategies in which learners take responsibility for their own learning so that they develop the attributes, habits and skills of motivated lifelong learners" (Kearns, 2001, p. 76). While there is a need to develop skills outside of academic skills, communication and more specifically literacy is singled out as a specific problem and it can be an elusive source of personal shame (Limage, 1993).

Although the research study by Watson, Nicholson, and Sharplin (2001) focuses on technician level ‘trainees’, there is much to learn from studies aimed at apprentices and other trainees whose work environment has many similarities. While their report focused on the basic needs of literacy and numeracy, employers of apprentices and other trainees considered English language and literacy skills to be important, along with organisational and interpersonal skills (Watson, Nicholson, & Sharplin, 2001). Both employers and employees identified the language and literacy skills as being in need of improvement. Other ‘employability’ skills such as computer skills, grammar and writing legibly, and interpretation of graphical information were also identified as being in need of improvement (National Centre for Vocational Education Research, 2001b).

There is a concern that employers have about their employee’s ability to perform tasks outside of their specialised academic field (American Federation of Teachers, n.d.). Several crucial skills common to high-skill jobs are listed, as being something every well-educated person should possess. These include the ability to work with budgets, interpret and disseminate information, demonstrate leadership, etc.

The learning experience during the student’s academic skills courses and programmes is the best place in which to learn these employability skills otherwise competition between academic and employability skills can occur. Acquiring generic skills necessary for cross skilling in the workplace may be appropriate for those tasks requiring only a lower level of knowledge and skills but may not be appropriate for tasks demanding a higher-level knowledge and proficiency (Pillay, 1997). It is suggested that a modern day employer will need people who are multi-skilled which is the process of developing across three dimensions, cross skilling, upskilling and higher-order thinking. These should be seen as complementing each other, to the extent that a person needs to be good on upskilling and be able to engage in higher-order thinking in all cross-skill areas to acquire a high level of multi-skilling ability.

In the late 1980s and 1990s, employers and educators in Canada recognised that the changing economy required a changing type of workforce. As these changes occurred, there was a call to employers to formulate and communicate the level of education and skills required of their employees (McLaughlin, 1995). Characteristics of what makes a person employable were identified in such areas as knowledge, know-how, attitudes, and behaviours. An Employability Skills Profile focused on generic foundational skills rather than specific skills for a certain occupation or responsibility. This profile was subsequently revised (Overtoom, 2000), and a brochure titled "Employability Skills 2000+" was published which identified the types of skills that were considered necessary for employment (The Conference Board of Canada 2000). Skills are sectionalised into three areas, Fundamental Skills, Personal Management Skills and Teamwork Skills. In the brochure, students, teachers, parents, employers, labour, community leaders and governments are invited and encouraged to use Employability Skills 2000+ as a framework for dialogue and action. The Ontario Ministry of Education lists essential skills as being reading, working with others, thinking, writing, oral communication, numeracy, using documents, and using computers (Ontario Ministry of Education, 2001). A database of Essential Skills that are the skills needed for work, learning and life, and which provide the foundation for learning all other skills, can be accessed to determine the essential skills needed for a range of employment positions (Human Resources and Skills Development Canada, 2003).

Where do people learn these all-important generic or employability skills? Do they learn them by the traditional manner in what can be described as 'becoming mature' or are they given the opportunity to develop these skills during the process of learning the academic skills associated with a chosen career path. The question is raised whether vocational education should concentrate on preparing students for specific jobs or should it be more focused on broader career development, including lifelong learning, employability, and cognitive skills (Lankard, 1996). This digest presents information in support of the latter, that career development should be supplemented with a learning environment that includes the development of those skills, values and habits that make a person more employable.

Gfroerer (2000) explores the use of competency-based assessment for skill areas such as communication skills, self-management and working with others while Carroll and McCrackin (1998) take the concept of competency-based strategies even further. They discuss the use of and need for these strategies to be used in the selection and development of employees and suggest that if this was a move in the business world, then the similar use of competencies in the learning environment would further enhance the student's ability to move from the learning environment into the work environment (Carroll & McCrackin, 1998). In the UK, registration as an Engineering Technician requires the demonstration of a list of key competencies that are considered necessary for this level of registration. These competencies incorporate many basic employability skills and include the need to be able to work individually or with others reliably and effectively without supervision, identify, organise and use both knowledge and resources to complete tasks, and communicate effectively in English using oral, written and electronic methods (Engineering Council, 2004).

Although Toohey (2002) discusses training for medical students, the writer clearly supports the need to consider personal attributes as part of the graduate profile, and as such, students are given opportunities to develop these personal attributes. The need to develop assessment around these personal attributes is discussed together with the need to make it part of the formal assessment framework. These personal attributes are difficult to assess and may not necessarily fit into the area of competency-based assessment. The effects of assessment such as reflection, self-evaluation and feedback are cited as good reasons to harness assessment in these areas of development (Toohey, 2002). "Changes to the skill development system must address barriers emerging throughout the education sector, from the work-readiness of school leavers, through pre-employment training to industry training and formal tertiary education. Individuals need clear pathways through these different parts of the education and training system to meet their changing learning needs" (Maharey, 2001, p. 5).

The actual determination of the essential employability skills or generic skills is more difficult and is a central issue to education reform to meet the demands of the move into a knowledge based society. The National Centre for Vocational Education Research (2001a), reports that the fostering of generic skills requires active learning strategies in which learners take responsibility for their own learning. As they develop the attitudes, habits and skills of motivated lifelong learners, the acquisition of generic skills becomes a lifelong process. Students need to be confronted with situations and problems with authentic tasks in order for the skills to transfer effectively to non-academic contexts. Tackling the problems in work-like contexts in the way they will eventually have to tackle them outside academia, will help students learn the necessary skills (Gibbs et al., 1994).

The responsibility of developing these skills is illustrated in learning environments that support action learning, situated learning and project-based learning, but there is a need for learning strategies to keep pace with technological change (National Centre for Vocational Education Research, 2001a). Developing transferable skills does however take time and resources. Demands are made on classroom time, student time, lecturer time in preparation and marking, and in some cases, special facilities. "Even if resources were readily available there would still have to be some tough decisions made if curricula were not to become over-full" (Gibbs et al., 1994, p. 3). This development of broad professional skills must be regarded as the ultimate aim of vocational training so changes in the education system curriculum should focus more on competencies such as learning to learn, interactive skills, communication skills, information processing, problem-solving and reflective skills (Tillema et al., 2000). Skills do not transfer easily to other contexts even when they are learnt in the context of an academic course because it is not sufficient to tack transferable skills on to conventional academic curricula (Gibbs et al., 1994). "To develop an integrated and effective skills strategy, issues concerning the quality and relevance of training and the effectiveness of learning pathways must be addressed alongside Government's initiatives to improve the performance of other parts of the post-compulsory education sector" (Maharey, 2001, p. 5).

Further consideration of writings on fair and equitable assessment suggest an inference that students who do not have a good command of the English language, especially those belonging to another culture, must not be disadvantaged (Gipps & Murphy, 1994; Parker & Rennie, 1998). Conversely, a study released in 2001 indicates the importance of apprentices and trainees having good English language and literacy skills. From this has come the conflict between those who argue that language should not be discriminated against, yet employers want graduates who have good oral and written communication skills and when English is the most widely used language, then assessment should include English as a skill. Competencies must include 'other' skills and therefore competency-based training and assessment involves not just simple building blocks, but these other skills as well (Tillema et al., 2000). Employers emphasised the need for good interpersonal skills and indicated they were less positive about their employees' English language and literacy skills than the employees themselves (National Centre for Vocational Education Research, 2001b). How then does a teacher deal with this issue of producing fair and equitable assessment when the student outcomes, graduate skills and the specified performance criteria of learning outcomes require oral and written communication competence?

2.4 ASSESSMENT AT TERTIARY LEVEL

The nature of learning and the purpose of assessment are reflected in the assessment practices associated in that learning and it is impossible to separate teaching, learning and assessment. Because assessment is the most significant motivator for learning, educational institutions need to consider whether assessment practice is equipping graduates with skill attributes such as critical thinking and lifelong learning capabilities, skills that are necessary for professional practice (Hargreaves, 1997). Registration as a professional Engineering Technician is open to everyone who can demonstrate competence to perform professional work to the necessary standards, and commitment to maintain that competence, work within professional codes and participate actively within the profession. Competence includes the knowledge, understanding and skills that underpin performance and it is attained through a mixture of education and professional development (Engineering Council, 2004). It is timely to consider what learning is and how this learning can be directed by the use of appropriate assessment strategies in order to produce graduates with the desired attributes (Nightingale et al., 1995).

In a project commissioned by the Australian government, eight modules have been identified that should be developed across programmes of study within higher education in order to improve student assessment (Nightingale et al., 1995). These are thinking critically and making judgements, solving problems and developing plans, performing procedures and demonstrating techniques, managing and developing oneself, accessing and managing information; demonstrating knowledge and understanding, designing, creating and performing, and communicating. If indeed graduates need to possess knowledge and skills that will allow them to enter professional practice, as well as attributes of lifelong learning, assessment practices need to be modified in order to achieve the desired educational outcomes (Hargreaves, 1997).

One approach to empowering faculty to develop sound assessment practice is provided in a publication “9 Principles of Good Practice for Assessing Student Learning” (American Association for Higher Education (AAHE) n.d.). These principles cover such aspects as the need to start with educational values so that the assessment acts as a vehicle for improving the kinds of learning most valued for the students, then continues by describing the need to encompass concepts of multidimensional, integrated learning towards clear, explicitly stated outcomes, over periods of time and involving staff from across the educational community. These concepts, together with the need for assessment to be part of a larger set of conditions that promote change, are focussed on meeting responsibilities to the students and to the public. It is therefore desirable that prior to any review of assessment practices, consideration be given to the nature of learning required in graduates (Hargreaves, 1997).

Facilitating learning in an adult environment is a complex issue brought about by differing purposes, personalities of the students, and perceived needs of the learning environment by the individual student (Brookfield, 1986). Adult learners in a classroom environment can be varied and display quite different characteristics. Their previous experience in the learning environment can greatly influence their perceived best type of learning environment and therefore what they expect and what they consider is their right because they are paying to be there. Being older can come with quite overwhelming marriage/family responsibilities that are compounded by the need for evening classes because of work commitments and the need for paid employment. Older students usually come with a greater maturity and a much greater desire of wanting to learn and achieve a pass grade or competency. Most will have experience in the workforce that may be related or totally unrelated to the subject content. These differing factors will impact into the learning environment as well as into the associated assessment regime within that environment (Corder, 2002).

Self-directed learning is one form of learning style that suits the adult environment (Brookfield, 1986). However, in order to change a student from a passive learner to a self-planned learner, the learning environment must be developed around the theme of developing and improving a student's ability to learn. Collaborative learning or learning projects are a means of creating a learning environment in which people learn as a result of their activity. In this environment, small groups of students at different learning levels work together on a given task. The environment in which they share and learn from each other is shown to enhance students' abilities in the area of critical thinking (Gokhale, 1995). This type of approach to the learning environment often requires a major change in the mind set or attitude of the teacher. The teacher's role is to serve as a facilitator for learning rather than as a giver of information, and they learn to make changes that can influence the learning environment (Tough, 1993). Students are not only responsible for their own learning, they are also active participants in the process of assessment where teachers act as reflective practitioners and do not judge student work against their own or other mandated standards.

These changes in the learning environment in turn assist the development of lifelong learning techniques and the preparation of students for lifelong learning, one of the essential skills of the modern society (Knapper & Cropley, 2000). Cooperative learning seems to be more attractive if it is adequately and formally assessed as it encourages students to make the most of their opportunities. Students work together collectively to perform and not to compete so peer and self-assessment is desirable to account for individual effort. In addition, cooperative learning offered many benefits to students in terms of graduate attributes such as teamwork, communication, lifelong learning and problem-solving (Gupta, 2004). As the popularity and use of project-oriented classes emphasizing hands-on education continues to grow, construction educators are faced with the challenge of evaluating student performance in this non-traditional setting. Proven authentic assessment techniques such as those including rubrics and portfolios can prove useful for teachers attempting to validate the satisfaction of industry desired competencies (Amos, 1998). As a result, the progress to an environment of collaborative learning, learning projects and authentic assessment will require a substantial shift of the responsibilities and roles for students, teachers, and administrators (Zessoules & Gardner, 1991).

Teaching staff, particularly in modern universities where recruitment is often on the basis of commercial, industrial or professional expertise, are also likely to be have drawn from a much greater range of backgrounds. They will probably not have undergone the long process of socialisation into academic norms (Mutch, 2002). This type of recruitment is one of the major obstacles to the progress in tertiary education, in that teachers are not teachers, they are what they have been trained to be, whether that be a tradesperson, technician, technologist, engineer or other professional person (Redish, 1996). The problem is compounded by the promotional system where teachers move into managerial positions and exercise decisions for teaching departments based on their lack of knowledge. This lack of understanding of learning methodologies, etc, can lead to misunderstandings and resistance to change and therefore there is a need to further discuss the need to incorporate new teaching and learning strategies based on educational research into Australian universities (Fraser & Cheers, 2000). Like many institutions of higher learning, academics are primarily interested in research or keeping up with changing developments that they either have little interest or little time, lack the motivation to change and have little understanding of how the learning can be improved. There is a need for change in tertiary education, where the professional doer becomes more like a professional teacher who has expertise in their chosen profession (Redish, 1996). While teaching staff in higher education are discouraged from attempting to implement innovative ideas that do not conform to internal and external quality control protocols, innovation in assessment is no longer an option. All assessment practices reflect a number of assumptions relating to the nature of learning and the purpose of assessment. If the intention of educational institutions is to equip graduates with knowledge and skills necessary for professional practice, then current assessment practices must be examined (Hargreaves, 1997).

2.5 NEW ZEALAND SITUATION

During the years before and after the establishment of the National Qualifications Framework (NQF) in 1997, documents continued to be published that covered various aspects of assessment within New Zealand learning institutions. In the book titled Beyond the Norm? An Introduction to Standards-Based Assessment (Peddie, 1992), the author acknowledges the vast amount of literature on assessment and that much has been written in New Zealand over the previous few years. The book continues by presenting information for teachers, tutors, trainers and course developers as an introductory guide to assessment for units registered on the NQF. Of particular interest is section 4 on standards-based assessment. The author summarises information from NZQA that "draws a clear distinction between the two main types of assessment, norm-referenced and standards-based assessment. Standards-based assessment is then divided into competency-based and achievement-based assessment" (Peddie, 1992 p. 21).

Norm-referenced assessment is expounded as being the type of assessment that compares the achievement of learners against each other on the same test or against previous groups. Assumptions contained within this concept are that assessment instruments remain ‘constant’ over time, that such an assessment was fair and that distribution of marks formed a ‘normal distribution’. While the NZQA was placing emphasis on the establishment of unit and achievement standards and the registering of these standards on the framework, NZQA continued to manage examinations as part of the assessment process. NZQA promoted the ideal that a good examination and its accompanying marking schedule should be related to the expected learning outcomes of the prescription (New Zealand Qualifications Authority, 1997). In that same document, NZQA offers best practice advice to teachers on setting and marking examinations, tests, etc. and characteristics of a good examination, planning, types of questions and marking schedules.

Standards-based assessment is expounded as being the type of assessment where the outcome is measured against some fixed criterion (Peddie, 1992). Of note is the possibility, in theory, of all students achieving the particular standard because of the NZQA’s intention of students having the opportunity of reaching the standard on more than one occasion. Competency-based assessment or criterion-based assessment uses a particular standard or criteria that students must reach to be judged as ‘competent’ and receive credit for the unit of learning. The use of the term ‘credit’ simply means that the required level has been reached and not the narrower meaning of ‘doing well’. In terms of the NQF, the term achievement-based assessment means “assessment in which a number of progressively more demanding standards are used, and in which all learner achievement is reported, usually in the form of a number or letter grade” (Peddie, 1992, p. 26). Trials at the sixth form level in New Zealand schools used grade-related criteria as a way of arriving at achievement-based assessment and these levels of achievement were linked to grades 1 (low) to 5 (high). Whereas in an examination a mark of 50% would meet the pass criteria, NZQA set conditions such as “a learner must gain a grade 3 or better in at least half the skill or knowledge area, and at least a grade 2 in the remainder” (Peddie, 1992 p. 26).

Problems with standards-based assessment, competency-based assessment and the pros and cons of achievement-based assessment are discussed in Peddie, (1995).

Although achievement-based assessment was considered to be only a temporary measure during the transition period to standards-based assessment, confirmed in a letter sent to schools by the CEO of NZQA on 16 November 1993, it did in effect become part of the framework by having both unit standards and achievement standards registered on the framework as standards towards the NCEA (Peddie, 1995). That letter of 16 November 1993 also stated that NZQA would no longer officially recognise the five-grade achievement-based assessment in the course of that learning. Achievement standards and associated marking schedules available from the NZQA website for the NCEA qualification illustrate examples of achievement-based assessment.

In the New Zealand edition of Competency-Based Assessment (Miller & Rutherford, 1996a), the writers outline what individuals and organisations are doing so that readers can better understand the positive changes a properly run competency-based assessment system can bring and why it is important to give these changes a chance. A summary of the key principles demonstrate that assessment approaches shall measure the range of knowledge and skills against competency standards, assessment approaches shall be as flexible as possible, assessment approaches shall be valid and reliable, and assessment approaches shall provide for the recognition of competencies held, no matter where they have been acquired. An important factor in competency-based assessment is for the teacher to know that the competencies were learned and that the candidate provided sufficient information to demonstrate that knowledge. Unlike other forms of assessment, competency-based assessment is not only a means of finding out whether or not an individual has the relevant skills and knowledge at a certain level, it is also a way of helping them increase those competencies and to gain others in a new and easy way (Miller & Rutherford, 1996a).

After a series of workshops sponsored by NZQA, and endorsed by the Association of Polytechnics in New Zealand (APNZ) and the Industry Training Federation (ITF), a publication was produced by NZQA (New Zealand Qualifications Authority, 2000), documenting information about the issues underpinning the principles of best assessment policy and practice in relation to unit standards. There are three principles covering areas such as assessment design, assessment decisions and sufficiency of evidence. Unit standards are statements of what someone knows or can do expressed as outcomes grouped together as elements. Performance criteria are the critical guidelines used to make a judgement on competent performance of the outcome and assessments should not focus on individual performance criteria otherwise it may lead to over assessment.

The purpose of most assessment practices prior to the introduction of standards-based assessment was to differentiate between students over a whole course of study (New Zealand Qualifications Authority, 2001). It was a probable expectation to 'spread' the marks for the whole course over a series of assessments and an examination. The examination where all students sat the same test within the same time limits was common practice to facilitate the process of testing everyone under standardised conditions. Marks from a range of assessments were added to indicate the relative success of each student and because students had to be compared with each other, norm referencing was common. The final results showed to what extent students had succeeded or failed over the whole course (New Zealand Qualifications Authority, 2001). Unit Standards on the other hand make targets explicit and require learners to meet the standard in full before they get credit. The purpose of assessment for the Qualifications Framework is to ascertain whether or not students have achieved the level of performance required by the unit standard. Good assessment will be systematic, open and consistent. It will use assessment methods that are appropriate, fair, integrated with work or learning, and manageable. Evidence will be valid, direct, authentic and sufficient, The published performance criteria must be used as the benchmark when judging whether the evidence meets the required standard and it is important that all the performance criteria are covered to the required standard (New Zealand Qualifications Authority, 2001). Assessment for purposes other than credit on the Qualifications Framework is entirely up to the individual teaching institution. "Framework results could be aggregated to produce rankings or whole-course results if that is what your institution requires. Your marking could produce marks or grades for local reporting and for your own institution's awards" (New Zealand Qualifications Authority, 2001, p. 3).

The government in New Zealand has recently been promoting discussion on skills required for employment. In the Industry Training Review discussion paper (Maharey, 2001), the Hon Steve Maharey, Associate Minister of Education (Tertiary Education) writes, "In short we need an integrated skills strategy, not just an industry training system" (Maharey, 2001 p. 2). The paper recognises that New Zealand's standard of living will be determined by the effectiveness of the skills strategy of the training system established to respond to global pressure in the workforce. More than ever before, the range of transferable, generic skills such as teamwork and communication skills, customer service and information technology skills are part of a greater proportion of jobs, and are necessary to allow a workforce to transfer between different roles and jobs. The importance of developing these skills was one of the key reasons why the Industry Training System was introduced in New Zealand. In order to ensure that employees are provided with an increasing standard of generic skills, the training system will need to adapt to a new level of quality and responsiveness. It is also important that "people need to develop the skills in their initial training that will enable them to go on learning as they go through life" (Sissons, 2002 p. 20).

The education providers within this system are the front line in providing the means to upskill the nation and need to lead the way in training the workforce that can respond to the changing skill needs (Maharey, 2002). However, "the needs of learners should be recognised as central to the design of the tertiary education system" (Tertiary Education Advisory Commission, 2000, p. 10). The future of Industry Training in New Zealand requires training that results in recognised and portable skills and qualifications (Skill New Zealand, 2001) and "The New Zealand Qualifications Authority is working closely with ITOs to place stronger emphasis on the development of multi-industry generic skills" (Skill New Zealand 2001, p. 6).

The Tertiary Strategy for New Zealand (Ministry of Education, 2002b) sets out in six strategies, a set of goals for tertiary education, how best to use the available resources and how tertiary education is going to make its contribution to realising those goals. Strategy Three recognises that all people need a good level of foundation skills to allow them to participate in a knowledge society, while Strategy Four takes this requirement of skills to another level. It acknowledges that New Zealanders need high-level generic skills to enable them to contribute to a knowledge society. Furthermore, the strategy will require providers of programmes to demonstrate that they are actively identifying base-line generic skill levels of entry-level students and providing for the development of generic skills as part of the programme. The strategy requires that by 2007, there will be a common understanding of what constitutes generic skills and that providers of training/education programmes will be dedicated to ensuring students acquire a high level of these skills. These skills are also needed to enable people to go on learning as they go through life, to evaluate how things are done and improve their ability in doing that work, and therefore must be embedded in all kinds of qualifications (Kerr, 2002; Sissons, 2002). "The diverse needs of learners, including those in full-time and part-time study, with different locations, must be central to the development of the system" (Tertiary Education Advisory Commission, 2000, p. 10). "Education providers are our front line in upskilling the nation. They need to lead the way in producing a highly skilled workforce, one which is capable of continuous learning and able to respond to changing skill needs, new technologies and global competition" (Maharey, 2002, p. 5). What New Zealand needs is an integrated skills strategy, not just an industry training system (Maharey, 2001). Until New Zealand develops what it considers are generic skills, training providers are left with the need to demonstrate that they are providing skills that meet the employability demand, whatever those skills may be.

2.6 ENGINEERING ASSESSMENT

In a continuously evolving society, the goals of engineering education are under perpetual discussion and this discussion impacts into the learning environment together with the adaptation of evolving educational methods. As assessment is highly related to the goals of engineering education, it would follow that assessment methods should also be evolving together with education. Thus the assessment of student learning, especially in an engineering environment, has a much wider impact than just marking examinations or papers of students (Gipps, 1994; Rompelman, 2000). It is important that there is relativity between course content, learning objectives and assessment types, and the teaching and assessment of those learning outcomes (Aldridge & Benefield, 1998).

The Accreditation Board for Engineering and Technology (ABET) establishes through an accreditation process whether a college or university program meets the quality standards established by the engineering and technology profession for which it prepares its students. There are eleven engineering criteria for accreditation under the title of EC 2000, a document that sets out intentionally undefined, outcomes for engineering educators to focus on as a necessary step in the accreditation process. The revolution of EC2000 was its focus on what is learned rather than what is taught while focussing on a continuous improvement process. The flexibility of the criteria set out in EC2000 meant that ABET could enable program innovation rather than stifling it, as well as encourage new assessment processes and subsequent program improvement. A National Science Foundation sponsored study developed and produced a framework, based on Bloom's Taxonomy, for better specifying the EC 2000 outcomes (Besterfield-Sacre et al., 2000). Using this framework, a substantive list of meanings was used to establish the outcomes framework that can be used as part of an assessment and feedback process. The framework allows individual institutions to develop their programmes to meet the assessment requirements and then through examining the meaning of the learning outcomes, consider how this could lead to an improved educational environment (Besterfield-Sacre et al., 2000).

Assessment of academic achievement based on the prescribed learning outcomes is dependant not only on the effectiveness of the presentation of the material and the test instruments used to assess learning, learning is also dependant on the environment in which a student learns. The importance of the learning environment is reflected by the various studies aimed at linking the various determinants to the effectiveness of the learning environment and the various instruments developed to assess the learning environment (Fraser, 1998). Learning environments need to be conducive for students to develop theoretical knowledge and lead students into the unfamiliar areas within the content and problem solving in order that they have the opportunity to develop capability. Likewise the focus of objectives of engineering education has evolved from knowledge to skills as a logical consequence of the changing demands of employers of graduated engineers (Rompelman, 2000).

This change in engineering education is further reflected in the changing views on assessment of student learning. In the medical school environment, student doctors should have their interpersonal skills assessed, not so much for marks or grades, but to harness the ability of an assessment program to unleash the desired learning and self-assessment in those areas of skills (Toohey, 2002). In a similar way, engineering education is evolving from the acquiring of knowledge that would last a 'lifetime' into one of skills that encompasses more than just knowledge. These skills include teamwork and problem-based learning, so an important part of the learning process of an engineer is the need to learn how to learn (Rompelman, 2000).

In the process of systems engineering theory, it is necessary to describe a transformation in terms of both the input and the output. In engineering education it is desirable to know the characteristics of the incoming students and essential to know the characteristics of the graduate engineers. Once these characteristics are clearly defined, the goals of the engineering learning process can also be clearly defined. Then these goals can be formulated into the learning objectives and the engineering education system can be developed (Rompelman, 2000). As part of this development, the assessment of student learning should be highly related to the goals of engineering education and this has a much wider impact that just setting and marking assessment exercises of students. As society continues to evolve, the goals of engineering education are also evolving. These goals should then be related to an evolutionary process of alternative educational assessment methods (Nataraj & McManis, 2001; Rompelman, 2000). One engineering schools approach to developing alternative educational assessment is in an engineering faculty where team members rank each other on their contributions to a team project and the marks distributed according to that score (Toohey, 2002).

Other learning tools such as concepts maps and Vee diagrams contribute to a successful classroom-learning environment alongside well written learning outcomes and research experience (Nataraj & McManis, 2001). Concept maps have also been used as an alternative method of assessment, especially when investigating relationships among concepts (Pendley, Bretz, & Novak, 1994; Turns, Atman, Member IEEE, & Adams, 2000). Electronic simulation is also a positive learning tool that can help stimulate problem-solving skills and enhance learning, while at the same time decrease the vast amounts of money to fully equip modern electrical and electronic laboratories. Evidence suggests that rather than student's learning being suppressed by the use of simulation, the opposite is true (Campbell, Bourne, Mosterman, & Brodersen, 2002; Jennings, 2002; Reed & McNergney, 2000).

An alternative method of course planning and learning assessment is described in an engineering design course where the components of design activity and the learning objectives are expressed within a framework (Safoutin et al., 2000). Learning objectives of design courses can be selected from among these components and the framework can also be used to guide the development of survey instruments for use in assessment. Four cognitive categories are used within the framework – knowledge, comprehension, application and analysis, as based on Bloom's taxonomy. The design attribute framework was used to develop the survey that in turn was used to assess students' learning. Good surveys (as with any assessment instrument) are difficult to design, especially when the learning objectives are poorly or loosely defined. Well-defined objectives provide a focus for desired learning outcomes in terms that are measurable (Safoutin et al., 2000).

No matter what approach to the learning environment is taken, there is still the problem of communicating the abilities of a student to that student or to future employers. Grades have their problems and disadvantages (Marzano, 2000), and an alternative is the competency-based structure. A major concern against grades is that grades are so imprecise that they are almost meaningless (Marzano, 2000). Teachers can grade the same students differently and grades can be split apart by one percent of the final mark. A change is necessary but the conception that grades are associated with ‘real marks’ produces resistance to change. Although grades can be used for administrative purposes, student feedback, provide guidance for students, provide guidance for teachers, and to motivate students, staff often appear to be more concerned with grades than they are with learning and students are being given the wrong message (Taras, 2002). A report on a study conducted by the National Council for Vocational Educational Research (NCVER) (Williams & Bateman, 2003), to update research on graded assessment in vocational education and training suggests that the implementation of graded assessment is inconsistent and fragmentary. While graded assessment is important, consistency in graded assessment was very important. Grading systems should clearly indicate to the learners good information on how they are to be graded and the criteria used in making judgements about their grade. It was recommended that grading be discretionary yet at the same time it was acknowledged that running both graded assessment system alongside a non-graded assessment system may become complex and costly (Williams & Bateman, 2003). However, as an important first step in promoting a change in assessment procedures, engineering educators who are interested in assessment should first turn their attention at adapting assessment methodologies from other disciplines (Shuman et al., 2000).

2.7 SUMMARY

The literature review has provided background literature that deals with the necessity and importance of having specific learning objectives and outcomes in order to facilitate meaningful assessment ‘measurement’, the need to incorporate employability skills into the learning environment, the advantages of a learning environment that fosters learning, collaboration between students and teacher, and general principles for the traditional norm-referenced assessment and for competency- or standards-based assessment. It has provided a lot of theoretical arguments, some of which proclaim the virtues of one educational philosophy as opposed to another, some that give an insight into a big picture of the classroom environment and some that provide insight into specific areas of concern with this study. Unfortunately there was no specific information on how to overcome the problem that I faced, in short, "many years of research by many researchers provided little guidance to school practitioners" (Gay & Airasian, 2000, p. 591).

Black and Wiliam (1998) suggest that policies seem to treat the classroom as a black box where the inputs from the outside are fed into the box and some outputs are expected. What is often not known or even considered is what is happening inside the box. Inputs are changed to theoretically improve the outputs but how can anyone be sure that a particular set of new inputs will produce better outputs if what happens inside as a result to those changes is not studied (Black & Wiliam, 1998). Teachers are given the responsibility for what is happening inside the box, and they have to make the inside work better (Black & Wiliam, 1998). Teachers are usually so busy thinking and acting on their feet responding to the input demands and internal crises that they find it difficult to make time to reflect on their practice (Hirsch, 2000). Reflection in turn assumes that teachers could make the inside work better and that policy changes in the inputs are not counterproductive and do not make it harder for teachers to raise standards (Black & Wiliam, 1998). Also it seems strange, even unfair, to leave the most difficult piece of the standards-raising puzzle entirely to teachers (Black & Wiliam, 1998) especially when teachers find it difficult to relate 'their' problems to the theory (Hirsch, 2000). In particular, "assumptions about assessment need to be formalised and articulated, so that they can be debated amongst a much larger staff constituency" (Mutch, 2002, p. 164).

In the tertiary sector, staff are also likely to be have been drawn from a much greater range of commercial, industrial or professional backgrounds. Recruitment is often on the basis of their work experience and expertise and they are likely to have little or no teaching training. They will not have undergone the long process of developing and understanding the norms of academic theory. These norms, especially those of adult learning and assessment, need to be communicated to teachers so they can start to think about and discuss their values (Mutch, 2002). In particular with assessment, a lack of institutional strategies to assist teachers rather than restrict them through compliance, leaves them on their own to learn and develop assessment methodologies. More often than not, these teachers fail to realise that assessment for learning is one of the most important purposes of assessment (Assessment Reform Group, 2002).

Despite the abundance of literature available, the specific question in this study of how to assess the same class and subject material to produce the required grade for the performance-based course and the required competency status for the standards-based course has not been answered. Many of the points for and against competency-based learning are discussed at length in articles such as (Kerka, 1998), but given the difficulties that teachers are presented with in order to conform to the requirements set by administrators and academics, these discussions do little to help resolve teacher's difficulties.

Hirsch (2000) suggested that the gap between theoretical research and practice in the 'classroom' is well documented. "Higher education researchers and practitioners live in different worlds; they rarely attend the same conferences, write for or read the same journals, and typically have little to say to one another. Theories generated by researchers are developed under conditions that are far removed from the changing, dynamic circumstances of the practitioners' world" (Hirsch, 2000, p. 99). There is a need for academic research, but there needs to be more focus on the formulation of strategies to create dynamic and iterative processes that give an opportunity for learning (Mutch, 2002). What is needed are reform initiatives that give direct help and support to the work of teachers in classrooms and the vigorous pursuit of policies that help support the everyday classroom task of achieving better learning (Black & Wiliam, 1998). "The encouragement of such learning and the provision of a framework for its realisation could be the most important feature of an institutional assessment strategy" (Mutch, 2002, p. 172). From an engineering perspective, capability is described as being "the indicator for the values of people who can take control of their situation, take action to resolve the problem and be able to communicate that information to others within a team, their superior or others under their management" (Stephenson & Weil, 1992). Engineering education needs people in education institutions, education bureaucracy and in business who can demonstrate the capability of resolving the problems.

Because the review of literature revealed no significant articles on how to approach or deal with the problem of dual assessment, the literature was then used to provide a foundational background for that part of the study and to provide information for the overall development of a theoretical model for a learning environment. This model considers both the inputs (policies, curricula, adult learning environment, assessment requirements, skills development, etc.) and the outputs (student outcomes for the students and reported grades for the institute's management).

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Many years ago I became interested in action research as a method or tool that I could use in my 'classrooms' as a systematic inquiry into my own practice of providing a suitable environment for tertiary students to learn. As such, action research became a meditative tool in my journey of many years as a teacher, a tool that was used in both the formally structured and documented situations and in the informal way of a note taking and reflective manner. This journey of many years had also been one of frustration from working in an environment which actively discouraged professional development of anything other than engineering theory and practice, but on the other hand, an environment which also sharpened my resolve to do what I could to learn to be a better teacher. This journey is not unfamiliar in many institutions of higher learning where emphasis is on discipline knowledge and the development of skills necessary to a good teacher are frequently under-rated. The obstacles to progress in tertiary education of teachers who are not teachers (Redish, 1996), teachers who become managers and exercise decisions for teaching departments based on their lack of knowledge (Fraser & Cheers, 2000), and working with others who lacked the motivation to change and learn how to become more like a professional teacher who has expertise in their chosen profession (Redish, 1996), were all part of my journey.

When faced with the situation that I found myself in with the necessity of simultaneously assessing for both an achievement-based qualification and a competency-based qualification, my natural reaction to colleagues who were saying 'it cannot be done', was, 'there has to be a way'. The journey from 'there has to be a way' to 'here is a way' over a relatively short period of approximately six months had been preceded with two years of trial and error 'tinkering' with the existing structure with no real success. The six-month period, which started with taking a fresh look at the whole picture and which included incorporating into the learning environment both new and successfully trialled learning practices, is the basis for this report. It is written in the form of a case study and takes a snapshot of what had been a many year journey of teaching/learning inventiveness based on action research. This period also turned out unexpectedly to be the final phase of my life as a teacher because of serious health issues relating to my wife and my subsequent early retirement. In some ways, this was unfortunate as it meant that further development and testing of the model outlined in this report had to be suspended.

Several different methodologies were used in this study and these methods are discussed under the following headings:

- Case Study (Section 3.2);
- Action Research (Section 3.3);
- Grounded Theory (Section 3.4);
- Questionnaire Surveys (Section 3.5.1);
- Interviews (Section 3.5.2);
- Employer Survey (Section 3.6);
- Development of a Framework of Learning Outcomes (Section 3.7)
- Validity of the Assessment Scoring Rubric (Section 3.8).

3.2 CASE STUDY METHODOLOGY

In the education scenario, case studies are written summaries of real-life teaching situations based upon research and data. These summaries can provide a picture of what has happened over a short period of time and can include events such as structure or arrangement change, strategy decisions within a learning environment and/or outside factors and influences. "Case studies can establish cause and effect, indeed one of their strengths is that they observe effects in real contexts, recognizing that context is a powerful determinant of both causes and effects" (Cohen, Manion, & Morrison, 2000, p. 181). Essentially, a case study could be considered to be a shortened version of a real-life situation that enables readers to appreciate and analyse real problems and events faced by teachers. They are a method of research that is suited to the small-scale researcher (Blaxter, Hughes, & Tight, 1996).

Traditional research tends to focus more on creating an artificial situation for the purpose of the research, whereas case studies are set in a natural setting that will likely exist before and after the research (Denscombe, 2003). The natural setting or situation of everyone's practice constitutes an individual event each time something happens so therefore, each event needs to be studied through individual cases (Jarvis, 1999). The key question for a case study is "What are the characteristics of this particular entity, phenomenon, or person?" (Gay & Airasian, 2000, p. 202).

In the natural setting of my classroom, I was able to perform the role of a participant observer and focus the case study on one instance of the situation that was being investigated (Denscombe, 2003), i.e. the report is like an in-depth macro snapshot rather than a broad picture. Case studies become special when they focus on one thing, one person, one classroom, one curriculum and one case and in my teaching environment, this was the situation. The case involved in a study can be very complicated or detailed and case study methodology helps to determine these things (Stake, 1997).

The narrow focus of a case study helps the researcher to look into the characteristics of the particular instance with the purpose of delving deeply. This intensive analysis helps to divulge the numerous and diversified circumstances of the instance of the study (Cohen & Manion, 1994). Because the focus of case study is the case and not a sample, researchers are empowered to understand and interpret the case with less emphasis on the broad picture (Stake, 1997).

Educational case studies begin in a world of action, the real life action of the teacher where the researcher can focus on the relationships and processes of the complex situations in a holistic approach (Denscombe, 2003) and through a multiplicity of research methods (Stake, 1997). This approach using multiple sources, multiple methods and different methodologies are indeed encouraged and in turn give the case study methodology its strength (Denscombe, 2003). Further strength is added through giving attention to the complexity of the case and through the ability to allow generalisations. Alternative interpretations are supported by the representation of the discrepancies or conflicts between frames of reference by giving attention to the social situation (Cohen & Manion, 1994). Case studies are also in-depth studies that present the opportunity to discover relationships that might otherwise have been missed (Denscombe, 2003).

It is suggested “that there are at least three categories of educational case study: theory-seeking and theory-testing case study; story-telling and picture-drawing case study; and evaluative case study” (Bassey, 1999, p. 12). The language and presentation of a case study report is usually less dependant on specialised interpretation and is less esoteric than conventional research (Cohen & Manion, 1994), or in other words, in a language that is simpler and familiar to teacher practitioners seeking information to help them in their own classrooms. Thus, case studies that begin in the real life world of action of the individual teacher will contribute to the real world of others through professional development and institutional feedback (Cohen & Manion, 1994).

The original and primary focus of this phase of my journey was to develop a workable methodology that would incorporate a reliable assessment framework for both achievement-based and competency-based assessment. Such a framework should work to support and enhance adult students’ learning while at the same time create a marking and record keeping protocol that was not burdensome to teacher or student. When initially faced with the problem of how to simultaneously assess what was effectively the same course in two ways, the initial attempt was to find some research or other material that would provide an insight into this educational and social difficulty. During this time I spent two years planning and acting on attempts in a trial and error process to find a solution, but had difficulty in producing a practical working model that satisfied the requirements of the simultaneous dual assessment. The third attempt involved going back to the basics and building a new model on which the practical model could be based.

3.3 ACTION RESEARCH METHODOLOGY

During this time of preliminary research and the trial and error of the previous two years, the many years beforehand and six months of the case study, the underlying mode of my work as a participant researcher was in action research. Traditional research tends to generally involve researchers in simulated environments whereas action research recasts the relationship between researchers and practitioners and involves the practitioners in the research process itself (Hirsch, 2000). The interaction between researchers and the researched subjects forms the basis for the quality of the produced knowledge and whether the project will succeed or not is highly dependent on this core process of action research (Boog, 2003). Action research is a form of practical research that is characterized by the reasoning of general laws and a focus on gaining a better understanding of a real life problem (Kuhne & Quigley, 1997). It can empower the teacher to become an agent of change and therefore fill the gap between educational theory and practice (Johnson, 2005). For those in the ‘real world’, action research involves the determination of the questions, the collection of data, and the analysis required to produce the results in order to solve problems and bring about change (Hirsch, 2000). As such, it is a form of research ideally suited to the single teacher working alone in the classroom, (as in my case study), a group of teachers working co-operatively within a school, or even by a teacher or group of teachers working alongside a researcher (Cohen & Manion, 1994). Teachers in a teaching situation “are therefore in a position to reflect on their teaching process, study it, and record their own reflections, attitudes, emotions and so on” (Jarvis, 1999, p. 90). It is of particular interest to practitioners seeking to bring about change (Hirsch, 2000) and it is essentially a systematic process of practitioner problem posing and problem solving (Kuhne & Quigley, 1997). “Action research is the process of studying a real school problem or situation” (Johnson, 2005, p. 27).

Action research requires both committed and intentional action (McNiff, Lomax, & Whitehead, 1996) and from the beginning, researchers have to approach action research with a sincere emancipatory intention and the desire to discover or learn something for themselves (Boog, 2003). It is a trial-and-error type approach to seek to understand and resolve practice-based problems and issues through the use of systematic procedures that combine analysis, observation, and data collection (Kuhne & Quigley, 1997). It is also an inquiry process that uses an informed action to investigate the teacher's own actions and motives, and through a critical analysis of these findings, to open the teacher to alternative viewpoints (McNiff et al., 1996). At the same time, both the researcher and the researched need to mutually support the learning process that will develop from the research project (Boog, 2003).

Action research allows the identification of items in the process that can be challenged by action, it increases the participants' understanding of themselves and their problems, it serves as an organizing strategy to get people involved, it develops confidence in the ability to take action based on hard data rather than on feeling, and then provides information and understanding to a broad audience (Hirsch, 2000). The research process functions as a catalyst for structural change and there is a co-generative research assessment procedure where the researcher and researched subjects reconstruct the research process and weigh the possible effects (Boog, 2003). "Action research involves a process of five important steps: identify a question, a problem or area of exploration, identify the data to be collected and the means of collecting the data, collect and analyse that data, describe the findings and report or share the findings" (Johnson, 2005, p. 21).

"Action research is a form of practitioner research that can be used to help you improve your professional practices in many different types of workplaces. Practitioner research simply means that the research is done by individuals themselves in their own practices" (McNiff et al., 1996, pp. 7-8). Important characteristics of action research include the cycles of research, experiential learning and action, and a common goal-orientedness focus that includes emancipation, empowerment, and participatory democracy (Boog, 2003). The reasons or purpose of using action research in a classroom include the characteristics that it is a means of remedying problems or improving a set of circumstances. It is a means of in-service training or professional development where teachers are equipped with new skills, improved analytical powers and increased self-awareness. It can be a means of demonstrating innovatory approaches to teaching and learning especially into a system that typically inhibits innovation and change, and it is a means of improving the communications between the practicing teacher and the academic researcher. Although lacking the rigour of true scientific research, it is a means of "providing a preferable alternative to the more subjective, impressionistic approach to problem-solving in the classroom" (Cohen & Manion, 1994, p. 189). Action research is a personal research process in that it focuses on putting the 'I' into the centre of the research and as such 'I' take responsibilities for my own actions and 'I' am the author of my own research accounts (McNiff et al., 1996). As a result, every action research project should also aim to enhance the professional development of other action researchers, i.e. the teachers (Boog, 2003; Johnson, 2005). Action research is therefore a method of research that "may be used in almost any setting where a problem involving people, tasks and procedures cries out for solution, or where some change of feature results in a more desirable outcome" (Cohen et al., 2000, p. 226). A further justification for action research is that research does not necessarily be applicable to all learning environments and "it is important for teachers to examine findings in their own context" (Gay & Airasian, 2000, p. 593).

The professional skills of the researcher to handle an action research situation include the ability to formulate and set up the action research in accordance with its basic assumptions, a knowledge of the chances that the research will be successful, sufficient self-knowledge to be able to know how to delegate research tasks to others where necessary, and it is important that researchers have the patience and the insights of a good teacher (Boog, 2003). Identifying the problem, finding a solution and testing the solution are the three stages of the process of solving real life problems in the classroom, an inherent part of the role of being a teacher (Johnson, 2005). "Unlike traditional research in which theory, developed by the researchers or academics, is used to illuminate practice, participatory action research invites the practitioners to develop context-rich theories of their practice and then use these theories to effect change" (Hirsch, 2000, p. 102).

The problem with a search of literature for some direction in the quest for a satisfactory assessment framework was that although there was an abundance of material in support of either method of assessment, at the same time many articles denounced one method of assessment in favour of the other. There was a significant amount of formally published articles that dealt with theoretical issues and as these were grounded in researched theory, they could be considered as being good literature review material but they did not offer much in the way of sound practical advice to the teaching practitioner. On the other hand there were those articles, particularly from the Internet, that were mainly unpublished and informal yet written in a way as to offer practical advice from one practitioner to another. I found these to be the most interesting and valuable. Impacting into these two categories of documents were those that presented various other aspects relating to assessment and training, and those that related to adult learning. During the process of a search of literature, other documentation was uncovered such as those from NZQA that dealt with various forms of assessment. This process of uncovering useful data is a part of the action research cycle.

The process of a search for suitable literature continued while the literature was consulted for suitable data. From this came the decision to start with a open-mind and attempt to construct a theoretical model that embodied the set requirements of the external education organisations, the internal institution documentation and course prescriptions. In order to clarify these initial areas of interest, a concept map was created in an attempt to clarify the links between these different categories. This map outlined what I considered to be the inter-relationships between data enforced into my teaching/learning environment by agents outside the classroom.

As the search for data continued, it quickly became obvious that the field of interest was becoming much wider than the original concepts of the two assessment options. The search for data was developed into a grounded theory approach as documents were consulted in order to produce a good theoretical model base. As well as the original concepts of data on assessment, the field of data research expanded to include the positive attributes of both forms of assessment, and other related classroom and teaching practices. The majority of these documents were quickly sorted into two major groups, those journal and book publications that reflected the more formal literature that was useful for literature based theories, and the informal material written by and for teaching practitioners useful as data for the theoretical model.

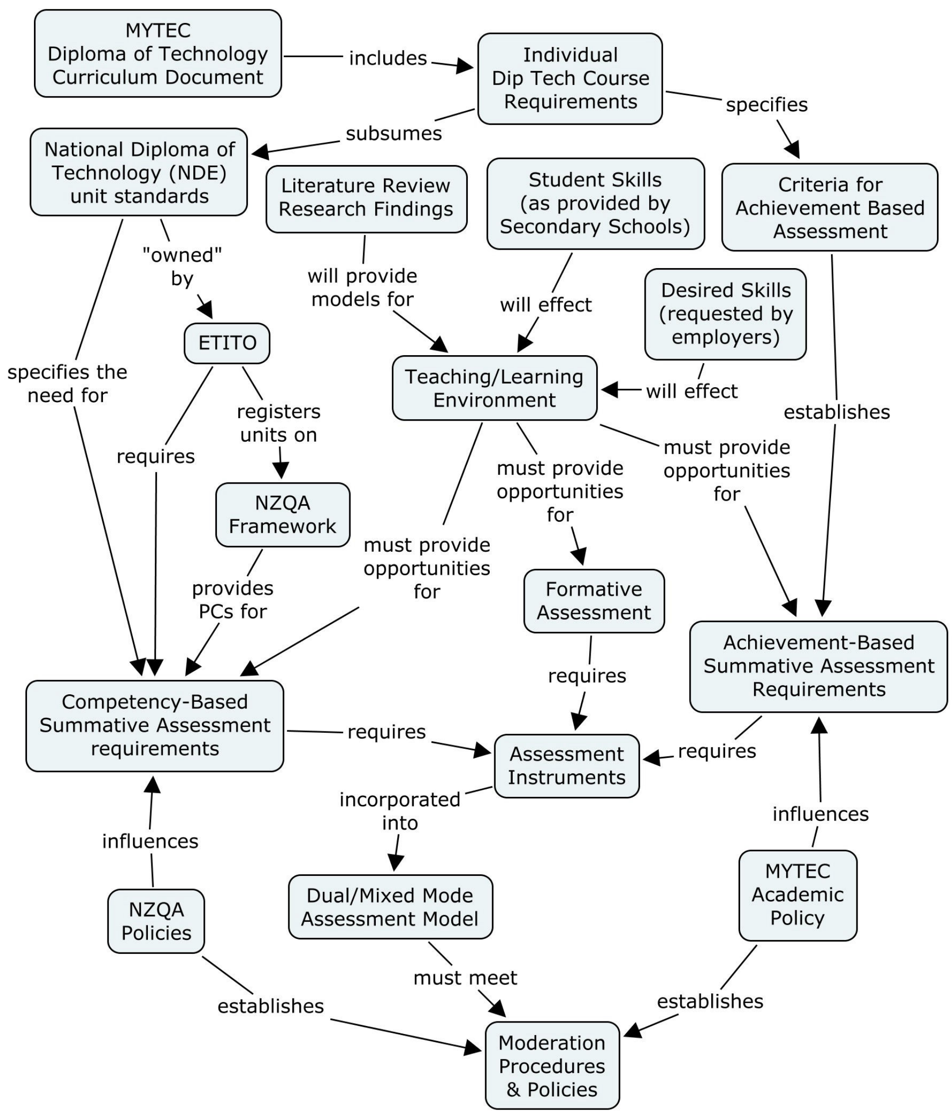

Figure 1.1. Reconstruction of original concept map

Research and practice methodology for this study became one of using grounded research for data gathering for the theoretical model, a quantitative survey for employer feedback, interviews and questionnaires for student feedback and statistical analysis of quantitative data, all under the umbrella of action research and presented as a case study.

The search for literature (and the subsequent development of the theoretical model), the development of the working model and the evaluation of the working model were conducted in three phases.

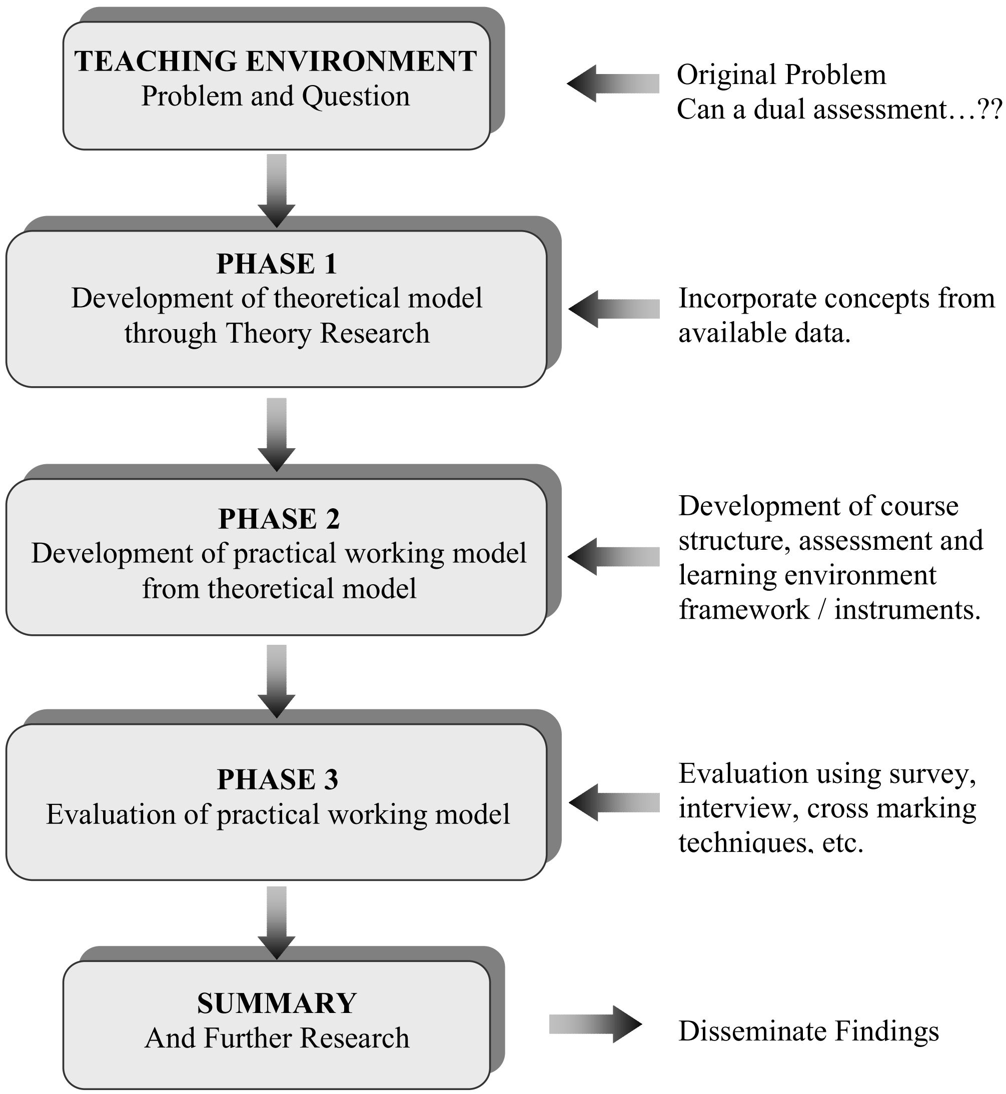

Figure 1.2. Flowchart of modelling phases

Phase 1 was the gathering of a large amount of data and the preliminary review in order to seek out the essentials that could help in the formulation of an answer to the specific assessment problem and to the learning environment as a whole. These data were initially loosely structured into the various categories and into the model as a whole, so as to release time for development of the framework and assessment material for the new semester. The formal compilation of the theoretical model occurred more recently during the process of documenting this study.

Phase 2 involved the development of a course structure, assessment and learning environment framework, assessment/marking rubric and assessment instruments.

Phase 3 occurred during the initial semester of trialling the working model and included a student survey, interviews and determination of validity of the marking rubric and of the allocation of marks.

3.4 GROUNDED THEORY METHODOLOGY

Grounded theory is a method of research that has been used extensively across a variety of social science disciplines requiring the study of the development, structure, and functioning of human society. The basic principle or belief underlying this approach to research is that a theory should emerge from the data, i.e. the theory must be "grounded in the data – this means it must come from the data" (Dawson, 2002, p. 19). Hence the significance of this approach is it's nature of inductive rather than deductive reasoning and it is known as an emergent methodology. Grounded theory is not so much concerned with the ideas existing in thought and not having a physical or concrete existence but rather places great emphasis on the usefulness in addressing real practical needs (Strauss & Corbin, 1990).

Grounded theory recognizes the importance that a good theory is one that will be practically useful in the course of daily events, not only to the social scientists, but also to laymen. "In a sense, a test of a good theory is whether or not it works 'on the ground'" (Locke, 2001, p. 59). The interrelated jobs of theory in sociology are: 1) to enable prediction and explanation of behaviour; 2) to be useful in theoretical advance in sociology; 3) to be useful in practical applications – predictions and explanation should be able to give the practitioner understanding and some control of situations; 4) to provide a perspective on behaviour – a stance to be taken toward data; and 5) to guide and provide a style for research on particular areas of behaviour (Glaser & Strauss, 1967). The grounded theory approach is useful when the research is qualitative, there is an emphasis on discovery, the data involves human interaction, and when the research is small-scale and conducted by individual researchers operating within a tight budget (Denscombe, 2003). Grounded theory is characterised by the desire of the researchers working in the hope that their theories will have a useful and practical application (Strauss & Corbin, 1990).

Grounded theory derives from the work of Glaser and Strauss (1967), who championed an ethnographic approach to undertaking sociological research, where theory should emerge from immersion in collected data (Taber, 2000). The resulting theory derived from the data should be grounded in research that is concerned with data that is verifiable by observation or experience and not on theory or pure logic (Denscombe, 2003). The process of grounding the theory in the data means that the theory must emerge from the data and then used to drive later data-collection methods (Scott & Usher, 1999). Hence a grounded theory is a theory that is discovered by allowing what is relevant to emerge (Strauss & Corbin, 1990), i.e. it is an emergent theory.

Traditional research starts from specific research questions (usually phrased in tightly defined terms, and often articulated in the form of testable hypotheses) whereas research to generate grounded theory deliberately avoids initially defining the research focus too tightly. Rather, the researcher enters the research context with a concern, or area of interest, that is felt to be worthy of study (Taber, 2000). Grounded research is therefore an approach that would elicit data that is not affected by a preconceived hypothesis or preconception and research, which is not predicated on hunches about what the issues may be and void of boundaries or limits on responses (Tuettemann, 2003). Accordingly, the explanations of events and situations need to be meaningful and relevant to those whose actions and behaviour are involved (Denscombe, 2003). What most differentiates grounded theory from much other research is that it is explicitly emergent. Research questions are open and general and the grounded theory process does not test a hypothesis. It sets out to find what theory accounts for the research situation as it is. These features of grounded research ideally suit the focus of this study. There was a concern or area of interest, no preconceived hypothesis to affect data or restrict research questions, void of boundaries other than those imposed by others, and it was explicitly emergent.

Some years after the original works by Glaser and Strauss in 1967, Strauss and Corbin wrote…

> Grounded theory methodology and methods (procedures) are now among the most influential and widely used modes of carrying out qualitative research when generating theory is the researcher's principal aim. This mode of qualitative study has spread from its original use by sociologists to the other social sciences and to practitioner fields, including at least accounting, business management, education, nursing, public health, and social work.
>
> (Strauss & Corbin, 1997, p. vii)

Initially, as with any piece of research, the process starts with an interest in an area one wishes to explore further. Usually researchers adopt grounded theory when the topic of interest has been relatively ignored in the literature, or has been given only superficial attention. Consequently, the researcher's mission is to build his/her own theory from the ground. However, most researchers will have their own disciplinary background, which will provide a perspective from which to investigate the problem. "Nobody starts with a totally blank sheet" (Goulding, 2000, p. 262). There is however a balance between having an open-mind without a rigid set of ideas that can influence the investigation, and having a perspective or focus on a general question or a problem in mind, and that of a 'blank' mind. An open-mind is not a 'blank' mind as it is likely that previous theories may exist but these are not allowed to influence the research and development of concepts (Denscombe, 2003). However the researcher's own experiences are also data that leads to concepts (i.e. the researcher can ‘interview’ themselves). The endeavour to commence the research with an open mind is known as ‘theoretical sensitivity’ in an attempt to ensure observations are coloured as little as possible by expectations based on existing theories (Taber, 2000). The need for a high level of theoretical sensitivity on the part of the researcher is therefore an inherent requirement. Because there is a need for the researcher to approach the topic without being influenced by previous theories, an extreme view would argue that a literature review of the subject is prohibited (Denscombe, 2003). However a literature review will provide a focus or place for the researcher to start.

A vital component of the grounded theory method is creativity and this allows a researcher to create a new theory out of the old or unknown. Creativity allows for free associations, the generation of new categories and stimulating questions that allows the researcher to identify relevance and consequences (Strauss & Corbin, 1990). Who or what is included in the study sample is unable to be predicted or identified prior to the start of the study because the development of ideas and concepts will follow a trail of discovery as each phase of the data gathering builds and reflects on that which has been discovered before (Denscombe, 2003).

The process by which the observations that we make are dependent upon our prior understandings of the subject of our observations is referred to as reflexivity, a process of taking account of itself or of the effect of the personality or presence of the researcher on what is being investigated (Siraj-Blatchford & Siraj-Blatchford, 1997). Because a person may be the researcher, a major respondent, the developer of the working model, the teacher who will eventually have to develop material and assessment instruments, and the person who will ultimately have to justify the social outcomes of the learning environment, reflexivity is recognised as a possible cause of invalidation.

There is a balance between the concern of reflexivity and an open-mind, because an open-mind is essential to grounded theory so that there would not be a rigid set of ideas that may shape the focus of the investigation (Denscombe, 2003). Despite conflicting perceptions over methodological transgressions and implementation, there is however a set of fundamental principles associated with the method (Goulding, 2000). Regarding the principles relating to this method of research, Strauss and Corbin wrote in 1998…

> This is not a recipe book to be applied to research in a step-by-step fashion. Our intent is to provide a set of useful tools for analyzing qualitative data. We hope that through our examples, readers will come to realize the fluid and flexible approach to data analysis provided by this method.
>
> (Strauss & Corbin, 1998) p. xi)

Then again in the same publication…

> Our version of qualitative analysis offers a cluster of very useful procedures—essentially guidelines, suggested techniques, but not commandments. We also offer a methodology, a way of thinking about and studying social reality.
>
> (Strauss & Corbin, 1998) p. 4)

Data collection and analysis are interrelated processes and analysis commences as soon as data starts to be collected. Data sampling procedures are derived from the three processes that are involved in the coding and analysis of data; open coding is when an interpretative process is used to break open the data analytically to identify relevant categories, axial coding is where categories are refined, developed and related to their sub-categories, and selective coding is where the central category is identified as a core category that ties all other categories in the theory in unified and identifiable relationships (Corbin & Strauss, 1990). Concepts are basic units of analysis and categories must be developed and related. Analysis of data should generate theories that have relevance to the practical world through coding and categorising of data and the constant process of comparing the emerging codes and categories with the new data as it is collected (Denscombe, 2003). These codes and categories will reveal an emerging theory that will enable the researcher to select comparison groups on the basis of their theoretical relevance thus avoiding the collection of a large mass of questionable theoretical relevance (Conrad, 1979).

The process of data collection is ‘controlled’ by the emerging theory (Goulding, 2000) and the process of modifying the category to fit the data and not select the data to match the category is known as emergent fit (Taber, 2000). Early in a project it is important to discover and identify data that is relevant to the research question through open sampling of persons, sites, documents, etc., and involve purposeful, and systematic procedures. As the project progresses it becomes important to locate data that confirms, elaborates and validates relations between categories or limits their applicability. As data are developed into concepts and concepts into theories, it is important to acknowledge that the main goal of developing new theories is their generation from the data while not emphasizing verification of the data to the point of suppressing the generation of that theory. The twin critiques of accurate evidence and verified hypotheses are likely to stifle generation of grounded theory if the development of new theories is not seen to be the main goal of the research (Glaser & Strauss, 1967). Thus “theoretical sampling provides comparisons that identify categories and their properties and that subsequently establish the uniformities, variations and relationships that are integrated into theory” (Kozma, 1985, p. 305).

Grounded theory relies on a method “in which data collection, coding, analysis, and theorizing are simultaneous, iterative and progressive” (Kozma, 1985, p. 304). A fundamental feature of grounded theory is the application of the ‘constant’ comparative method (Goulding, 2000) and this is the process by which data produce the generation of a theory. There is a constant process of reviewing the emerging model against the data collected (Taber, 2000) and this is known as comparative analysis because the analysis of the data produces emerging concepts that when compared with existing concepts, have fit and relevance (Glaser & Strauss, 1967). There should be a concerted effort to allow the data to generate theories through the persistent process of analysing data and improving ideas by comparison with existing data (Denscombe, 2003; Tuettemann, 2003). Thus constant comparative analysis is a strategic method of generating theory that can be used to its fullest generality for use on social units of any size. Its usefulness for a small organisational unit such as classes in a school has been demonstrated (Glaser & Strauss, 1967). Because the constant comparative method as used in grounded theory permits by its design the kind of flexibility that aids the creative generation of theory, it contrasts with the inflexibility of most traditional methods of analysis which are designed to ensure that two or more analysts working independently with the same data will arrive at the same or similar results (Conrad, 1979). Although the comparative analysis of the data is an important process, it is the conceptual theory or property of the category that was generated from the analysis of the data that is the goal of the study. Thus the concept may be generated from one piece of data or many pieces of data (Glaser & Strauss, 1967). As concepts are identified and the theory starts to develop, further consideration of data may need to be incorporated in order to strengthen the concepts. This is known as 'theoretical sampling' where the process of data collection seeks to develop the theory as it emerges by the collection, coding and analysing of the data by the researcher. "Theory should not precede research but follow it" (Cohen et al., 2000, p. 23).

Theoretical sampling is used to describe how decisions about on-going data collection are guided by the emerging theory as the research becomes more focused. Within the process of generating grounded theory, theoretical sampling should be cumulative and include a sense of building on previous samples, a process of collecting data for comparative analysis, provide a increased depth of focus, be consistent and follow a reasoned course while retaining some element of flexibility (Conrad, 1979; Denscombe, 2003). Theoretical sampling serves a different function to random sampling, which is a method used to test hypotheses and it is used because it provides assurance that the result is representative of a larger group (Kozma, 1985). The decision that an endpoint to data collection has been reached is not dependant on a pre-specified number of data sources at the beginning of the research (Dawson, 2002), but rather is made by a process of 'theoretical saturation', that is where further data collection and analysis does not significantly change the model being developed (Taber, 2000). A theory is considered saturated when it is abundant in detail and new data does not produce change (Pandit, 1996) so that collection and analysis of data should continue until theoretical saturation is reached – i.e. the point when new data contributes little to discovering anything new about the category (Denscombe, 2003; Goulding, 2000) or when any improvement in categories due to new data is minimal (Pandit, 1996). One of the major advantages in the generation of theories is that grounded theory may be presented in different ways, for example, as a set of propositions or as a running theoretical discussion (Glaser & Strauss, 1967). Therefore, an important part of the presentation of the theory is to chart the process as it evolves using diagrams that illustrate the emergence of the theory (Goulding, 2000). Because there is often a considerable amount of data, it is necessary to be selective in the presentation of suitable data to present a meaningful picture of the emergent theory (Goulding, 2000). In describing the four stages in the constant comparison method of developing a theory from data, Glaser and Strauss (1967) effectively summarize the process. First, compare incidents that are applicable to each category. Second, integrate categories and their properties. Third, delimit the theory, and fourth, write the theory.

3.5 SURVEY METHODOLOGIES

Two principle methodologies were used in the process of capturing data from those people involved in the study, namely the questionnaire survey and the interview. Because questionnaires are more suited to obtaining answers to standardised questions whereas an interview offers a better possibility for obtaining meaning data from questions generated from the previous response (Tuckman, 1999), the questionnaire survey was used to capture data from prospective employers of future diploma graduates and from students enrolled in the courses, and the interview was used to obtain further elaboration on the responses to the students' questionnaire.

3.5.1 Questionnaire Surveys

The use of a questionnaire offers many advantages to the researcher. These advantages include the ability of questionnaires to be administered without the presence of the researcher, they allow a structured approach, and they encourage pre-coded answers that facilitate the provision of readily interpreted quantitative data (Cohen et al., 2000). Advantages also include a relatively low cost, the ease at which they can be arranged, they supply standardised answers, and they can be confidential or anonymous. Questionnaires may however present difficulties in obtaining personally sensitive and revealing information (Tuckman, 1999).

Evaluation of the appropriateness of a research questionnaire and the associated survey should include whether the questionnaire provides coverage of vital and accurate information for the specified research, that the survey will provide an acceptable response rate, and that both the survey methodology and the questionnaire layout recognise the rights of respondents (Denscombe, 2003). As a guide, questionnaires are most appropriate when large numbers of respondents are involved, the information that is sought is fairly straightforward, there is a need for standardised data, and the respondents can be expected to be able to read, understand and respond to the questions (Denscombe, 2003). To qualify as a research questionnaire, questionnaires should consist of a written list of questions, gather information by asking people directly about the points that are of concern in the research study and be designed to collect information that can subsequently be used as data (Denscombe, 2003).

There are at least eight principles that will guide the design of questionnaire items. These principles include reliability of responses, validity of the measurement, discrimination between key variables, response rate, whether the different respondents interpret the same meaning, whether the question is relevant, whether there is sufficient response alternatives to exhaust the possible responses, and whether the responses are sufficiently exclusive (de Vaus, 2002). Questionnaire items should also be simple, direct, specific, and use clearly worded questions that minimise ambiguity (Blaxter et al., 1996; Tuckman, 1999). Questionnaire questions may be ‘open’ (where the respondent chooses their own wording, the length and the matter of the response), or ‘closed’ (where the respondent chooses a category that has been established in advance) (Dawson, 2002; Denscombe, 2003). ‘Open’ questions lead to qualitative data whereas ‘closed’ questions lead to quantitative data.

During the construction phase of the questionnaire design it is important that the analysis of the responses is also considered (Dawson, 2002), and the allocation of a serial number allows for the relational identification of data within a respondent's set, together with that respondent, date of distribution, etc. (Denscombe, 2003).

Questionnaires should include background information about the research, who the sponsor of the research is (i.e. is it an individual research or an institutional research), the purpose for the survey, a return address and date, a confidentiality statement, an acknowledgement that responses are voluntary and a statement of thanks for the cooperation (Denscombe, 2003; Gay & Airasian, 2000).

Disadvantages of the questionnaire include the possibility of a respondent's frustration with pre-coded answers, the possibility of bias towards the researcher when pre-coded questions are used, poor response rates, inability to probe or explain items, and there is little time to check the truthfulness of the answers (Denscombe, 2003; Gay & Airasian, 2000). Questionnaires can also limit the kinds of questions that can be asked and the kinds of answers that can be obtained (Tuckman, 1999).

Asking a person to complete or respond to a questionnaire will always be an intrusion into their life, and as such, respondents can only be asked and encouraged to become involved and then to remain involved. The decision is theirs because they are subjects and not objects of research (Cohen et al., 2000).

3.5.2 Interviews

One of the essential tools in the toolbox of the educational enquiry researcher is interviewing. This is because few other research methodologies can capture the preconceptions, perceptions and beliefs of those involved in educational settings (Scott & Usher, 1999). Interview data are most commonly used as a source of information gathered alongside other methods as a way of supplementing detail and depth and therefore it can be used to prepare for a questionnaire, follow-up on a questionnaire, or to triangulate with other methods (Denscombe, 2003).

The interview method of research involves the questioning and discussion of issues with people and is therefore a very useful technique for the collection of data that would be difficult to obtain using observation or questionnaire methods (Blaxter et al., 1996). Interviews can probe items for in-depth information, they involve a face-to-face experience with the informant, they are flexible in terms of the questions to be asked, they can provide a large amount of data, and they are usually associated with a usually high response rate. Disadvantages include the bias of the interviewer, interviews are time-consuming, the respondent has no anonymity, training is required, the scoring of the unstructured items can be difficult and the whole process depends upon a small group of key informants (Gay & Airasian, 2000; Hughes, 2002).

When someone agrees to an interview, it is more than just a conversation and as such, there are certain issues that must be considered. The interview does not happen by chance like a conversation, but rather interviews require planning and preparation in order to investigate a given topic. This usually occurs when the researcher has reached a point where the research would be better served by a more in-depth insight into that topic and that an interview is a reasonable option to pursue (Denscombe, 2003).

Interviews can range from totally informal, conversational type exchanges to sessions that are highly structured during which close-ended questions are asked (Tuckman, 1999). They are more conveniently considered as those that are unstructured, semi-structured, or structured (Dawson, 2002). Face-to-face approaches to interviews can also be considered as being an informal conversational interview, a standardised open-ended interview or a closed quantitative interview (Hughes, 2002).

The most common type of semi-structured or unstructured interview is the one-to-one variety involving a meeting between the researcher and the interviewee. Such meetings are easy to arrange and the data of opinions and views come from one source. However in each case, the researcher controls the proceedings of the interview and this will vary according to the style of the interview (Denscombe, 2003).

An interview provides an opportunity for interviewees to discuss their interpretations of the world and to express situations from their point of view (Cohen et al., 2000). As such, the results of the interview must be understood by the interviewee as being part of 'the record', and that the words of the interviewee are taken as a genuine reflection and can be used at a later date by the researcher (Denscombe, 2003).

The reasonability of an interview can be considered in light of a positive response to considering whether the research requires that kind of detailed information, and whether it is reasonable to rely on information gained from a small number of informants. A positive response would usually justify an interview because of the nature of the data; i.e. data that is based on emotions, experiences and/or feelings, data that is based on sensitive issues, or data based on privileged information. The feasibility of an interview needs to be considered in terms of the ease of direct access to the interviewees and the viability in terms of cost of time and travel (Denscombe, 2003).

The validity of the response can be compromised by what is known as 'interviewer effect', that is, factors such as personal identity, and self-presentation and personal involvement. These effects can be minimised by providing and encouraging a good climate for the interviewee to feel comfortable, for the researcher to listen and learn from the interviewee, and that the interviewee understands the underlying approach of the interview (Dawson, 2002; Denscombe, 2003).

A researcher needs to be rigorous and methodical when doing interviews for research (Hughes, 2002), and it is important that the researcher considers the research ethics involved in an interview because an interview is an open meeting intended to produce material that will be used for research purposes. There is a need for the researcher and interviewee to understand this and for the interviewee to agree to the interview (Denscombe, 2003). It is important to remember that an interview is not simply an opportunity just to collect data, it is part of life itself with the constraints of everyday life (Cohen et al., 2000).

3.6 EMPLOYER SURVEY METHODOLOGY

Part of the on-going institutionalised culture in the discipline in which I worked was the intent that it was more important to 'get through the material' than to seek to improve students' learning and the learning environment, and to include the development of what is now known as employability skills. I remember chancing across an unpublished document circa 1991 that documented a research project in which employers were surveyed to ask them to rate 10 skills in order of importance. Amongst skills such as oral communication, written communication, working with others, learning on the job, etc. was theoretical knowledge. The results of the survey indicated that employers rated these other 'skills' more important than theoretical knowledge which they placed very low out of the 10 (lowest is least important). About the same time I also chanced on an advertising poster in the business studies area of the institution which was from a large NZ company wanting graduates with one of a list of several business related degrees. The inference I took from the wording of the advertisement was that obtaining a degree demonstrated the ability with skills, so that the company could then train staff for their company. With the advent of the competency-based unit standards and performance criteria which indicated a need for support of employability skills such as written communication skills (e.g., "the description provides a coherent statement of the concepts"), there was an increased interest in testing the correctness of the argument that theoretical knowledge and 'getting through the material' were the most important. As part of my literature search, I also chanced across the research report of an Australian Employer Satisfaction with Graduate Skills survey (Department of Education Training and Youth Affairs, 2000). As a response to this report, an article was published in Engineers Australia (Beder, 2000), which supported the need for a more holistic approach to engineering education. The article suggests that it is no longer satisfactory to attempt to cram students full of technical knowledge in the hope that it will enable them to do whatever engineering task is required of them throughout their careers (Beder, 2000).

Initial queries at my place of work left confusion over whether such a survey had been conducted throughout New Zealand, particularly at the diploma level. I contacted NZQA, Dept of Labour, Tertiary Education Commission, Ministry of Education, Industry Training Federation, Engineering Associates Registration Board, ElectroTechnology ITO and Skill New Zealand and in each case they indicated no knowledge of a graduate skills survey for a graduate technician. Without the knowledge of the specific skill attributes a graduate diploma student needs to possess in order to satisfy a prospective employer's needs, it would be difficult to develop a programme that will maximise a student's prospect of employment. The need then was to determine a prioritised list of skills desired by industrial employers of graduate technicians to either confirm or re-establish a benchmark for students' skill based learning outcomes. This list can also serve to establish a set of goals or mission statement for a programme against which a programme assessment can be measured.

Inspired by the Australian research report, the Beder article, and a lack of any data from a skills survey in New Zealand, I decided to conduct a survey to determine the desirability of work skills for graduates with a diploma level of electrical/electronic engineering. Social surveys of this nature have characteristics that include a wide and inclusive coverage, be attended to at a specific point in time in order to bring data 'up to date', and it is research that seeks to find the information that is 'out there' rather than that which is based solely on theoretical considerations (Denscombe, 2003).

The survey used in this study sought to confirm or otherwise the necessity to consider work skills as part of an engineering diploma education, that is, do prospective employers want new graduates to be 'crammed full of theoretical knowledge' or have a range of skills. This survey approach to information or data gathering is not a research method, it is a research strategy and as such a wide range of methods can be used in order to focus on a wide coverage, inclusive data and at a specific point in time (Denscombe, 2003). In order to achieve these characteristics, the strategy of the survey was to contact as many as possible of those employers who were likely to employ diploma graduates, to ascertain from these employers the types of skills they consider necessary in today's workplaces.

The many factors that need to be considered with a new questionnaire are question formats (e.g., direct versus indirect questions, specific versus non-specific questions, questions of fact versus opinion, questions versus statements, predetermined versus response-keyed questions) and response modes (e.g., unstructured responses, fill-in responses, tabular response and scaled response) (Tuckman, 1999). There are also many different types of surveys such as telephone interviews, face-to-face interviews and postal questionnaires (Denscombe, 2003).

In order to minimise the cost and time factors of designing and constructing a new questionnaire and survey strategy, and to minimise the necessity for testing of a new set of survey form questions, the survey form used in this survey was modelled on the response items used in sections 8, 12 and 13 of the Graduate Skills Report survey form (Department of Education Training and Youth Affairs, 2000) and presented as a single page questionnaire. Permission to model the questionnaire form on the Australian survey was requested and approval was granted from the Commonwealth Copyright Administration, Intellectual Property Branch of the Department of Communications, Information Technology and the Arts.

A list of prospective employers were taken from the Universal Business Directory and the Yellow Pages as those seen to be businesses associated with the electrical/electronic industry, either directly (as in electronic communications equipment) or indirectly (as in a dairy goods processing plant). The procedure for administering the questionnaire survey considered the points as set out in texts such as Tuckman (1999), and also followed the concept used on the Australian Graduate Skills Report (Department of Education Training and Youth Affairs, 2000).

The list of prospective employers was obtained from the Universal Business Directory, the Yellow Pages and from other business sources and entered into a database. This database was then linked to the Initial Phone Questionnaire and a one-page document printed for each employer. This document recorded the initial company details, provided a guide to take the research assistant through the telephone conversation, and provided space for contact details and any address changes. The initial screening contact was made by telephone to confirm that the company would indeed recruit diploma graduates and to confirm a suitable contact for the completion of the questionnaire. A cover letter and the questionnaire were then sent to that person and upon return, the responses entered into a database prepared for that purpose. In this manner, any bias in the sampling frame was minimised by the searching of appropriate employers, screening with the initial telephone contact, identifying an appropriate and willing person to complete the questionnaire and a follow-up contact for any non-responses.

The survey was ended when it was proving difficult on a time/result ratio to locate further businesses that may employ or recruit diploma graduates. Sample size and non-responses bias was minimised by noting that changes to the overall ranking of the results by the continuation of entering data was minimal (i.e. the grounded theory, theoretical saturation approach). Once the results were analysed, they were used to confirm the theoretical model.

The same questionnaire was also used to survey the students to ascertain their perception of the necessity of developing employability or work skills. Comparison of these results with those indicated by the employers, indicated the necessary focus to bring students' thinking into line with those of employers.

3.7 DEVELOPMENT OF A FRAMEWORK OF LEARNING OUTCOMES

The need for and the development of a framework of the learning objectives and performance criteria for classroom learning and student assessment are particularly essential in this study. Both the Dip Tech achievement based programme and the NDE competency based programme have been derived from the original NZCE, yet the presentation of the learning objectives for both diplomas is essentially different. If the assessment criteria for the two diplomas are to be simultaneously promoted in the learning environment, then it is essential to demonstrate the correlation between the two. This correlation of learning objectives is essential for several reasons. A teacher needs to have clearly stated behavioural objectives for their classroom instruction and also to be able to evaluate whether their instruction was effective (Popham, 1998). A lesson plan should have clear objectives so that teachers will be able to focus on that lesson plan and hence maximise the opportunity to promote learning (Kizlik, 2004a, c). Students will know exactly what they need to able to achieve after each lesson topic and the students will have a clear indication of their expected performance prior to each assessment (Popham, 1998). Fair assessment also requires both teacher and student to have clearly stated learning outcomes (Suskie, 2000). While clear and concise learning objectives can be clearer and easier to understand, there is a need to understand that small or narrow instructional objectives does lead to teachers being overwhelmed with keeping records of individual objectives (Popham, 1998).

The meaning of the learning outcomes need to be examined to consider how these could lead to an improved educational environment (Besterfield-Sacre et al., 2000). In articles such as Kizlik (2003) and Kizlik (2004b), lists of verbs and their suggested meanings are described that can be used to interpret defined behavioural objectives. This becomes difficult if the learning objectives or learning outcomes are poorly written in the first place, so as managers of the process, teachers should be encouraged and empowered to do three things: "(1) Clearly formulate the educational objectives, (2) Create an environment such that the objective is most effectively and efficiently arrived at by the student, (3) Develop and carry out an assessment procedure, suitable for the educational objective" (Rompelman, 2000; p. 344). Learning outcomes are usually associated with 'performance criteria', but these do not express outcomes. The term 'performance criteria' indicates "the minimum evidence to consider when making a judgement as to whether the candidate has achieved the outcomes of the element and therefore, the standard" (New Zealand Qualifications Authority, 2005, p. 2).

Different terms are used to describe the statements of focus for learning and assessment. These include 'objectives' (Kizlik, 2004a, c; Safoutin et al., 2000), ‘behavioural objectives’ (Kizlik, 2003, 2004b; Popham, 1998), ‘learning outcomes’ (Besterfield-Sacre et al., 2000; Suskie, 2000), ‘educational objectives’ (Rompelman, 2000) and ‘outcomes’ (New Zealand Qualifications Authority, 2005). For the sake of simplicity, the term ‘outcomes’ is used as much as possible in this document.

The traditional approach to assessment with the NZCE courses was to have a defined set of learning outcomes and assessment criteria for each outcome. Each course was assessed through internal achievement-based assessment and by an achievement-based external examination. A pass mark was required for each and norm referencing was applied to marks and the pass mark was adjusted if necessary.

A perceived problem with this approach to assessment is that while there was some effort made to write an examination to meet the learning objectives, there were times, especially with a change of examiner, that significant redevelopments of the examination content would favour some students and disadvantage others. Even though assessment criteria were provided, the objectivity was somewhat obscure with some criteria worded in such a way as to raise questions as to what actually is required from the student. For example, the assessment criteria “Numbers are converted to/from the decimal number system to either binary or hexadecimal” can actually be done with a calculator or computer, or done in a simple form through the use of mathematical steps. Another assessment criteria “Flip-flop operation is described using truth tables” is problematic as the dictionary meaning of the word ‘described’ is “give an account in words of (someone or something), including all the relevant characteristics, qualities, or events” whereas a truth table is primarily a table of numbers used to denote logic states. A further concern was because the examination was a major and essential part of accumulating marks for the student, the learning and internal (course) assessment process became directed towards and by the examination, i.e. assessment of learning.

With the introduction of Unit Standards and the listing of outcomes and their performance criteria came the opportunity to take a fresh look at assessment and develop more interesting and challenging authentic assessment opportunities that would develop the characteristics and performance skills required of graduates by prospective employers. The listing of the actual performance criteria using recognised behavioural objectives was a significant step in preventing the examination from driving the learning and assessment topics. Because the MYTEC Diploma course prescriptions have essentially been developed by absorbing the original NZCE learning outcomes and assessment structure, they retain some of the difficulties associated with the use of the term 'performance criteria'. Some colleagues also had some difficulty trying to teach or facilitate a learning environment based on Unit Standard outcomes rather than using the outcomes to develop of learning framework that provided the necessary learning opportunities.

In this study, it was necessary to work within the directives of the institution and the course prescription, so it is acknowledged that the focus should be on assessment for learning and not on assessment of learning. However, in terms of the more legalistic requirements, this section must concentrate on creating an assessment framework that attempts to meet the criteria imposed into the classroom by including good practice and learning methodologies, and the competency-based and achievement-based assessment requirements.

The rationalization of the outcomes for the two diplomas was sought to provide a focus for desired learning outcomes in terms that are measurable (Safoutin et al., 2000). In particular, the two behavioural objectives used in the NDE unit standards are 'describe' and 'apply' and both these words infer that a student should be able to demonstrate their competency through performance assessments. Performance assessments include many different forms of written, oral and/or practical demonstrations and activities, and involve either an individual or a group (Roeber, 1996). Because performance assessments require students to demonstrate the application of knowledge to a particular context, they are set apart from other assessment activities that focus primarily on knowledge (Brualdi, 1998; Wiggins, 1993). Effective performance assessments can provide an understanding of what the student knows, what the student does not know and what misconceptions the student holds with respect to the purpose of the assessment through the analysis and/or observation of a student's response by the teacher (Moskal, 2003).

Before a performance assessment or a scoring rubric is written or selected, the teacher should clearly identify the purpose of the activity. As is the case with any assessment, a clear statement of goals and objectives should be written to guide the development of both the performance assessment and the scoring rubric. 'Goals' are broad statements of expected student outcomes and 'objectives' divide the goals into observable behaviours (Rogers & Sando, 1996). Questions such as, 'What do I hope to learn about my students' knowledge or skills?', 'What content, skills and knowledge should the activity be designed to assess?', and 'What evidence do I need to evaluate the appropriate skills and knowledge?', can all help in the identification of specific goals and objectives (Moskal, 2003).

While the emphasis in this study is on the rationalization of outcomes in the two diplomas rather than the writing of new objectives, it is worthwhile considering the following recommendations for writing goals and objectives (Moskal, 2003) in order to provide a clear focus.

1. The statement of goals and accompanying objectives should provide a clear focus for both instruction and assessment.
2. Both goals and objectives should reflect knowledge and information that is worthwhile for students to learn.
3. The relationship between a given goal and the objectives that describe that goal should be apparent.
4. All of the important aspects of the given goal should be reflected through the objectives.
5. Objectives should describe measurable student outcomes.
6. Goals and objectives should be used to guide the selection of an appropriate assessment activity.

If the term 'objective' is replaced with 'outcome', then the focus on rationalization of outcomes is sharpened.

Outcomes therefore provide focus, revelation, relationship, description and guidance, and have three essential parts:-

- Condition - which describes the conditions (i.e. the circumstances, commands, materials, directions, etc.) under which the behaviour is to be performed.
- Behavioural verb - the action word that suggests an observable feature of the students' performance.
- Criteria - a statement that specifies how well the student must perform the task.

Guidelines for the development and management of performance assessments or outcomes are outlined and discussed in the article by Roeber (1996). Although this article is directed at performance assessment that is more than the typical test and examination, the suggested guidelines are worthy of consideration.

The suggested steps include…

1. The development of the assessment framework, which consists of the assessment objectives.

   In this study these assessment objectives are jointly provided by the interpretation of the Dip Tech course prescription outcomes and the associated Unit Standard outcomes. The knowledge of the expected skills profile of a diploma graduate will also underpin assessment objectives.

2. Creation of the assessment plan that will provide a general summary of the types of assessment to be used.

   The plan must fit under the umbrella dictated by the assessment weightings specified in the Dip Tech prescription, i.e. assignments and laboratories (20% of marks), tests (20% of marks) and examination (60% of marks). The structure and emphasis of the laboratory exercises and the assignments are within the management of the learning environment, tests are open for learning environment intervention but should consider providing experience for students preparing to sit the end of course examination which is established from outside the domain of the learning environment.

3. Determination of assessment resources.

4. Production of the assessment blueprint that should outline the characteristics of the chosen assessment.

   These characteristics should provide information on how the assessment will meet the individual requirements for both the Dip Tech and Unit Standard, and how the assessment will meet the requirements for each outcome.

The steps that I used in this study were…

1. Development of the assessment framework.
2. Creation of the assessment plan.
3. Determination of assessment resources.
4. Development of a marking system.
5. Production of the assessment blueprint.
6. Production of assessment instruments.
7. Establishment of the learning environment.

The working model was trialled for one semester of two separate courses that were programmed in parallel. During that semester a selection of surveys and tests were conducted to evaluate the working model.

3.8 VALIDITY OF THE ASSESSMENT SCORING RUBRIC

This section outlines a simple study design to assess the validity of the assessment scoring criteria in producing acceptable marks as opposed to the use of the traditional marking schedule to generate marks.

Because the course documentation specified the requirement to incorporate an examination and tests as part of the assessment schedule, and the need to use a nationally produced examination, a simple test of the validity of the assessment scoring criteria was made by comparing marks produced via the scoring rubric with those using a traditional scoring or marking schedule that I have developed and/or used for many years in national and institute based examinations. Because the setting and marking of tests was under my 'control', the tests were originally marked using the scoring rubric system and then remarked using the traditional marking schedule.

The total marks gained by each method were then statistically compared. The correlation and regression between two variables was then computed. Correlation is an indication of the measure of strength of the linear association between two quantitative variables, whereas the regression equation describes dependence of one variable on the other variable (Moore & McCabe, 1989). The Pearson correlation coefficient, r, is the square root of R2 expressed as a decimal. Its size is always between 0 and 1. A correlation greater than 0.8 would be described as strong, whereas a correlation less than 0.5 would be described as weak.

3.9 SUMMARY

In summary, this report is a case study of an event which occurred in my teaching/learning environment while using action research principles in order to solve a problem and which became a multi-method approach in order to delve deeply into the multi-faceted relationships that existed. An important aspect of the multi-method approach to this research was the focus on the ethical issues in relation to the employer questionnaire and the students' questionnaire and interview. Employers were assured of their confidentiality and this was achieved. Students were assured that in doing this research that they had the right to withdraw at any time, that they would not be identified in any published material, and that interruptions to their study and learning would be minimal.

Within the case study, different methodologies were used in an endeavour to satisfy the needs of the different studies embraced within the overall study.

- A case study approach was used in the overall study.
- Action research methodology provided the drive and intuition to focus on change used in the initial trials and then in the development of the learning and assessment framework.
- A grounded theory research review of available literature provided information for the development of a theoretical model and of the assessment marking rubric,

- A quantitative questionnaire postal survey was used to supply employer data for the desirability of graduate work skills.
- The quantitative questionnaire on work skills was also completed by students in order to determine their interpretation of important work skills.
- A qualitative survey was used to obtain student feedback regarding the use of a marking rubric.
- An interview was used to obtain information regarding student satisfaction.
- Quantitative analysis was used to investigate reliability of the marking rubric.

Further development and evaluation of the model was then suspended because of the change in my personal circumstances.

CHAPTER 4

DEVELOPMENT OF A THEORETICAL MODEL

4.1 INTRODUCTION

Ask a tertiary teacher about assessment and the response will probably include the assessment of student's learning. Ask a more 'academic learned' tertiary teacher about assessment and the answer would probably include assessment for student's learning. Mention assessment to a senior academic administrator and the response is likely to be that it is a measure of the success of a programme. Ask a non-academic senior manager and the answer would probably include the demonstration of accountability. In every case, assessment has little meaning unless there are clearly defined outcomes against which to make the assessment. The establishment of a set of outcomes against which the theoretical learning of a student can be measured, is therefore a fundamental requirement for both achievement based assessment and competency-based assessment.

Assessing a programme is quite different. One approach is to ascertain feedback from students, another approach is a simplistic summary of academic results, and another could be employer satisfaction with graduates. But what skills do prospective employers desire of graduates of technology diplomas? In New Zealand the Government has been promoting the need to develop skills for the workforce, but what are these skills? What makes the teaching/learning environment successful? What practical suggestions for student learning are there? How does a teacher use successful assessment for learning and of learning? These questions need to be answered so a profile or model for the teaching/learning environment of a Diploma in Technology student can be clearly established. Therefore the goal of this phase of the study is the development of a theoretical model that can be used to focus attention on the variables that impact into the teaching/learning environment and answer some of these questions. Only then can meaningful student and programme assessment be made and teaching staff empowered to create the appropriate learning environment.

In Chapter Two, a review of literature associated directly or indirectly with the learning environment was presented and discussed. Most of that literature was presented from the perspective of the broad picture and also from a theoretical perspective. It sets the groundwork for further investigation. Like building a house, it has drawn the plans and cleared the section. This chapter then is like the construction of the foundations and the framework of the building. There is a need to dig into literature, to search other information and provide a more practical practitioner based structure for the learning environment.

Section 4.2 introduces an initial understanding of the theoretical learning environment, an environment that more often than not is one where the new tertiary teacher is placed with little preparation. Section 4.3 outlines the employability skills survey, a study into how prospective employers view the importance of employability skills. Section 4.4 outlines the grounded theory approach to the development of the theoretical model and Section 4.5 outlines the source of the data and categories. Section 4.6 provides an overview and an analysis of the theoretical model categories and the associated data and Section 4.7 outlines the development of the theoretical model from these categories. An overview of the significance of the theoretical findings is presented in Section 4.8, and finally Section 4.9 summarises the chapter.

4.2 UNDERSTANDING THE ENVIRONMENT

The suggestion from (Black & Wiliam, 1998) that policies seem to treat the classroom as a black box where outside inputs are fed into the box and outputs are expected from the box, quickly became a reality throughout this part of the study. The case study approach allowed me to focus on the 'black box' that was my situation and at the same time, step back from being in the picture in order to see the picture. In this way, I was then able to focus the study on the case (Stake, 1997), undertake an in-depth study of the different data categories, and then use the case study methodology to formulate an understanding of the situation. This process of standing back and seeing the categories that made up the big picture enabled me to focus on each category at a time. Where data in a category were 'authoritative' and imbedded in one document, this process of delving deeply revealed the complexity of directive inputs, yet where data were suggestive and often revealed by delving deeply and the analysis of many documents, the process revealed good suggestions that support the teacher in the teaching/learning environment. Thus each category was analysed to discover how it impacted into the overall case. This intensive analysis helped to reveal the diversified circumstances of the case (Cohen & Manion, 1994) that in turn empowered me to understand and interpret the case with less emphasis on just the broad picture (Stake, 1997).

The focus on the emergent theory was not so much concerned with questioning the validity of the data as they were obtained, but more aligned to obtaining categories of data to create an understanding of the big picture of direct and indirect expectations that are inputs to and outputs from the teaching/learning environment, i.e. 'the black box'. As Black and Wiliam (1998) suggest, inputs are often created with little consideration of what is happening inside the box. Some of these 'inputs' that are in effect expectations of teacher performance, seem to have been created from an output perspective. The broad but in-depth searching and analysis of data that were the focus of this stage discovered the difficulties presented to the teacher by these inputs. An example is an institution policy that states, "In summary, the assessment procedures used by this institution (and its constituent Faculties and Departments) are the procedures by which accountability can be demonstrated to students, management and wider public" (MYTEC institution policy). This is seemingly at odds with such statements as "The needs of learners should be recognised as central to the design of the tertiary education system" (Tertiary Education Advisory Commission, 2000, p. 10). Both are 'directive' inputs into the learning environment and yet they suggest opposing considerations for assessments – assessment for demonstration of accountability vs. assessment for learning.

TEAC also pronounce as one of its ideals, "The tertiary system needs to be designed to respond to the challenge of lifelong learning in a knowledge society, and this may require new ways of organising, delivering and recognising tertiary education and learning" (Tertiary Education Advisory Commission, 2000, p. 12). This could be considered an idealistic input that assumes institution strategies would support this focus and not suppress innovation in the teaching/learning environment. In the midst of internal crises such as having to produce and administer simultaneous assessment and crises that make it difficult for teachers to make time to reflect on their practice (Hirsch, 2000), teachers are deemed by institute policy to be responsible for assessment. They must ensure that assessments have the qualities of appropriate, fair, reliable, and manageable methods; valid, direct, sufficient and authentic assessment evidence; and judgements that will be consistent, open and credible (MYTEC Assessment Policy). As the data were collected and analysed, a 'big picture' of the expectations on teachers became clearer.

4.3 EMPLOYABILITY SKILLS SURVEY

The primary focus for this survey was the need to determine a prioritised list of skills desired by industrial employers of graduate technicians to either confirm or re-establish a benchmark for students' skill based learning outcomes. The list can also serve to develop a programme that will maximise a student's prospect of employment and establish a set of goals or mission statement for a programme against which a programme assessment can be measured. The list of skills used in this questionnaire consisted of twenty-five items distributed over four groups or categories and employers were asked to indicate the relative importance of each.

The list of prospective employers was obtained and each company contacted by telephone for initial screening and determination of a suitable person to complete the questionnaire. A cover letter and questionnaire was sent to that contact and the returned data entered into a database. One follow-up telephone call was made to those contacts from whom a completed questionnaire was not received. As the data were received, it was entered into a database that used an ID code to relate data with the employer. This facilitated analysis and enabled graphs and tables to be produced.

A total of 379 employers were initially contacted by phone to enquire whether they would be likely to employ a graduate student. Of those employers, 280 were sent a questionnaire and 238 returned completed questionnaires that were entered into the database as data.

The database also held data associated with the employers specific industry and an analysis of those employers who returned a completed questionnaire shows a range of industries are represented by the survey.

Table 4.1

Employer Skill Survey Industry Statistics

Industry of Employers	
Automation and control	16
Communication systems	9
Computer systems and services	14
Consulting Engineers	9
Design Engineering	8
Electric supply industry	6
Electrical contracting	20
Electrical equipment and services	11
Electronic equipment and services	57
Electronic servicing and/or maintenance	11
General mechanical manufacturing	25
Machinery sales and service	3
Marine Electronics	6
Product manufacturer	31
Research	1
Switchboard design and manufacturer	11
Total replies	238

Table 4.2

Employer Skill Survey Contact Statistics

Employer Contacts	
Employers contacted by telephone	379
Employers who were sent a questionnaire	280
Questionnaires not received by return mail (despite a follow up phone call)	42
Completed questionnaires	238
Response rate from initial list of employers	63%
Response rate from questionnaires sent to an employer	85%

Saturation of Theory

As the survey progressed, it became more difficult within the time and financial constraints to continue to locate further employers from which a completed questionnaire could be solicited. In keeping with the spirit of grounded theory research, theoretical saturation was deemed to have been reached when the addition of further completed questionnaire data collection and analysis did not significantly change the model being developed. A guide to this theoretical saturation can be obtained by analysing the data at intervals through the order in which data entry was made. When theoretical saturation is reached, any resulting change as data were added and analysed would not significantly change the order at which the employers ranked the importance of the skills.

A comparison at mean value response at 50%, 80%, 90% and 100% of the final number of samples shows an initial change for many skills, a less significant change as the number of entries increased, and virtually no change in ranked order. As this occurred, the data, responses and ranked order were deemed to have reached theoretical saturation.

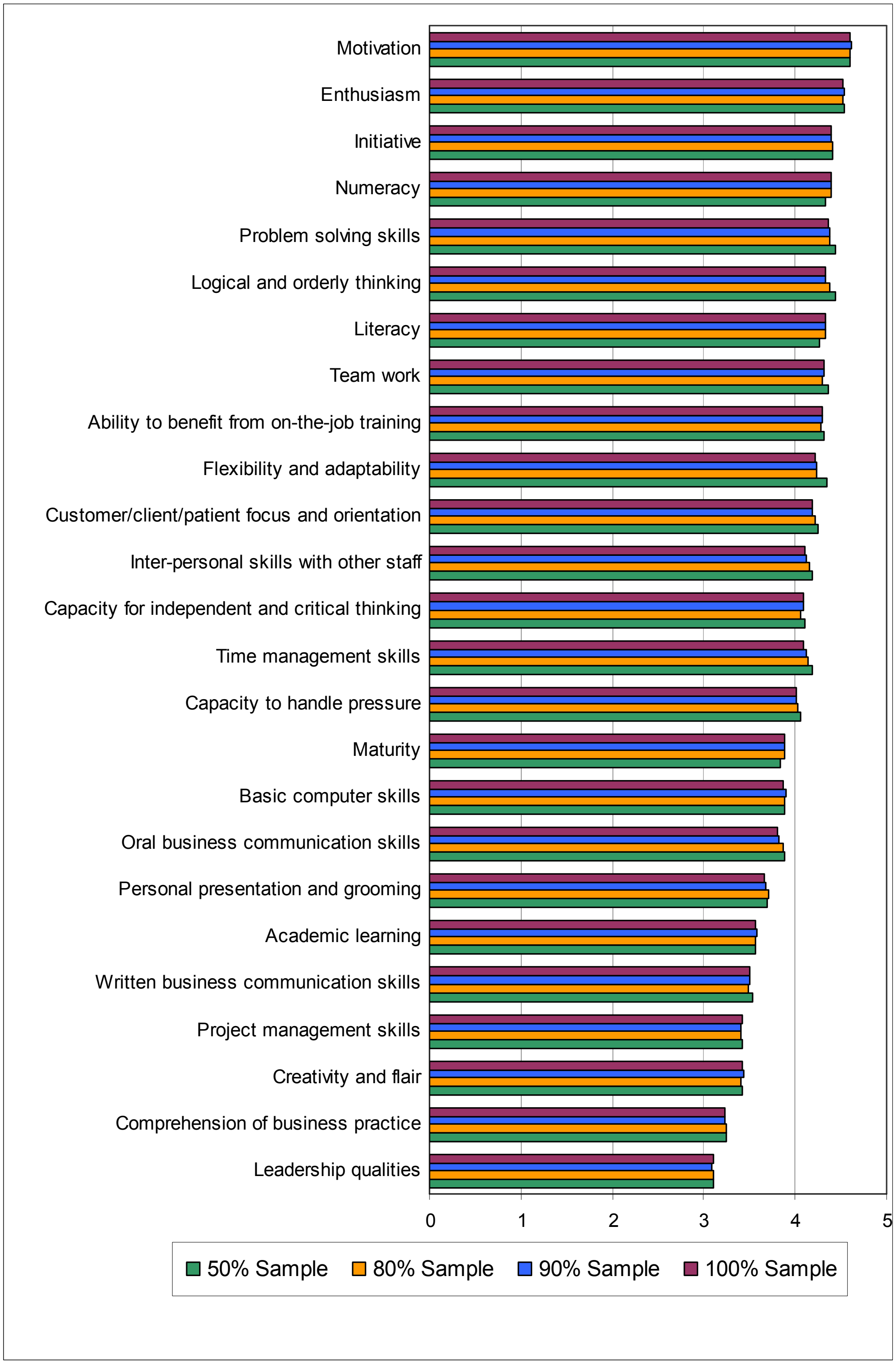

Figure 4.1. Skill survey saturation and ranking

Table 4.3

Items Used in the Employer Skills Survey

Basic Competencies	Literacy
	Numeracy
	Time management skills
	Basic computer skills
Basic Skills	Inter-personal skills with other staff
	Leadership qualities
	Oral business communication skills
	Comprehension of business practice
	Team work
Academic Skills	Academic learning
	Written business communication skills
	Problem solving skills
	Project management skills
	Logical and orderly thinking
	Creativity and flair
	Capacity for independent and critical thinking
Other Attributes	Enthusiasm
	Motivation
	Initiative
	Maturity
	Personal presentation and grooming
	Capacity to handle pressure
	Flexibility and adaptability
	Customer/client/patient focus and orientation
	Ability to benefit from on-the-job training

A comparison of the ranked order of the skills associated with their skills grouping reveals a strong desire for graduates to possess skills other than just academic skills. The three skills that are ranked as being the most important are from the other attributes skills group

Table 4.4

Skill Survey Ranking and Skills Groups

Skill	**Skill group**
Motivation	Other Attributes
Enthusiasm	Other Attributes
Initiative	Other Attributes
Numeracy	Basic Competencies
Problem solving skills	Academic Skills
Logical and orderly thinking	Academic Skills
Literacy	Basic Competencies
Team work	Basic Skills
Ability to benefit from on-the-job training	Other Attributes
Flexibility and adaptability	Other Attributes
Customer/client/patient focus and orientation	Other Attributes
Inter-personal skills with other staff	Basic Skills
Capacity for independent and critical thinking	Academic Skills
Time management skills	Basic Competencies
Capacity to handle pressure	Other Attributes
Maturity	Other Attributes
Basic computer skills	Basic Competencies
Oral business communication skills	Basic Skills
Personal presentation and grooming	Other Attributes
Academic learning	Academic Skills
Written business communication skills	Academic Skills
Project management skills	Academic Skills
Creativity and flair	Academic Skills
Comprehension of business practice	Basic Skills
Leadership qualities	Basic Skills

Table 4.5

Number of Responses per Questionnaire Item for Each Category of Response

	Response No						
Questionnaire Item	**DK**	**1**	**2**	**3**	**4**	**5**	**Mean**
Motivation	0	0	0	2	91	145	4.60
Enthusiasm	0	0	0	8	98	132	4.52
Initiative	1	0	0	16	106	115	4.40
Numeracy	1	0	2	21	92	122	4.39
Problem solving skills	1	0	1	17	108	111	4.37
Logical and orderly thinking	3	0	1	17	108	109	4.33
Literacy	1	0	2	27	96	112	4.32
Team work	0	0	4	27	98	109	4.31
Ability to benefit from on-the-job training	1	0	2	16	124	95	4.30
Flexibility and adaptability	0	0	2	24	132	80	4.22
Customer/client/patient focus and orientation	3	0	5	34	95	101	4.19
Inter-personal skills with other staff	3	0	1	37	119	78	4.11
Capacity for independent and critical thinking	0	0	4	40	123	71	4.10
Time management skills	1	1	1	48	109	78	4.09
Capacity to handle pressure	1	0	5	45	125	62	4.01
Maturity	0	0	4	68	116	50	3.89
Basic computer skills	0	5	7	73	81	72	3.87
Oral business communication skills	0	2	11	65	113	47	3.81
Personal presentation and grooming	0	2	12	80	113	31	3.67
Academic learning	5	0	13	82	112	26	3.57
Written business communication skills	1	3	14	100	99	21	3.50
Project management skills	0	3	29	98	81	27	3.42
Creativity and flair	2	5	22	93	94	22	3.42
Comprehension of business practice	1	2	35	117	68	15	3.24
Leadership qualities	2	3	39	131	51	12	3.10

4.4 THE GROUNDED THEORY RESEARCH PROCESS

An educational case study will begin in the real life world of action of the teacher where research can focus on the relationships and processes of the complex situations in a holistic approach (Denscombe, 2003). Thus this part of the study began with curriculum documents and institution policies relating to the discipline area, proceeded through searching the library catalogue for books, searching journal articles, searching the internet for both published and unpublished material and using references from articles and books to further extend the search, a search that expanded as a holistic approach to determining relationships. This approach through a multiplicity of research methods is part of case study methodology and gives this type of study its strength (Denscombe, 2003; Stake, 1997). What started as a focus on a search for information on simultaneous assessment, lead to the expectations placed on a teacher by the employer through institution policies, and spread to an encompassing framework that contained both directive and supportive data for the teaching/learning environment. The range of relevant categories expanded as data were obtained and relationships were developed and attention to this revealed the complexity of the case. This in-depth study approach presented the opportunity to discover the relationships that might otherwise have been missed (Denscombe, 2003). Some generalisations in the combining of data and any alternative interpretations that I as the researcher may have introduced because of the complexity of the case, are part of the strength of case studies (Cohen & Manion, 1994).

The development of categories and the conceptual theory or property of each category generated from the analysis of the data is the important principle, not the comparative analysis method. Thus the concept and its theory or property may be generated from one piece of data or many pieces of data (Glaser & Strauss, 1967). As a vast amount of data were readily available in libraries and via the Internet in the form of journal articles as well as personal or institution websites, an approach to the research was taken that would capture as wide a sample of these data as possible under the constraints of time, mental absorbability and theoretical saturation. The primary source in terms of quantity of data came from searching the Internet and

Internet databases of journal articles. The secondary source was via the library (available or interloan) with documentation from organisations directly or indirectly involved with the research subjects. An underlying source of data was held by myself, who after 30 years of adult teaching experience and directly involved in the courses and the environment of the institution, had knowledge of verbal reports back from other institutions via department management, informal discussions with colleagues over the years, and data from various minor research activities. Although data from oneself can be argued are not valid data but a feature of a closed-mind, other writers put forward the conviction that as the observer of the data is a participant and has worthwhile data in which to ground the theory, acceptability of that data comes under the umbrella of 'self interviewing'. An open-mind (but not a blank-mind) is essential to grounded theory so that there would not be a rigid set of ideas that may shape the focus of the investigation (Denscombe, 2003). A further source of data came from previous evaluative exercises done under the umbrella of previous study but which are part of the theoretical model, and the survey of employers taken to ascertain desirability of student developing 'employability skills' during their training.

Within the concept of this study, a literature review had been taken in the process of understanding the big picture of the assessment difficulty and this established concepts that had not been previously considered. Within these concepts, the great deal of literature on assessment presented itself as belonging to one of two generalised main themes – the theorist approach that discusses such aspects as the pros and cons of alternative assessment theory, and the practical approach outlining methods that practitioners had developed and used in practice. It was within this latter group of data that the grounded theory approach was more focused in order to saturate the data in a particular category. Theoretical saturation was reached as the selection of categories for the data collection and subsequent analysis from Internet based researching did not significantly add to understanding the focus of this study.

In this study it could be argued that there is a real possibility of categorising data before the research began (i.e. the two forms of assessment) yet there is also the argument that data on assessment would quickly produce these two categories. However in each of these categories lies the opportunity to use data to generate a theory that in turn becomes a sub-theory or subset of data that could then be used as part of the formulation of the main theoretical model. As each article or document was read, it was coded at two levels of assimilation, the broad category or topic of assimilation (e.g., competency-based assessment, achievement-based assessment, learning environment, etc.) and the level of assimilation - Must Assimilate (MA), Should Assimilate (SA), Could Assimilate (CA). Some categories, such as the MYTEC Academic Regulations, consisted of only one document but categorised immediately into its own category and coded as MA.

Coding of data generally involves open coding (where data are broken open to identify relevant categories), axial coding (where categories are refined, developed and related) and selective coding, where the "core category", or central category that ties all other categories in the theory together). Coding in this part of the study involved the use of all three methods. Open coding was used with data such as government based or institution policies or reports. As these documents are in the main reasonably extensive with more material than that required in this study, the documents were 'broken open' to obtain the relevant material which was then placed in their specific category. Axial coding was used for data that were more orientated towards good practice principles. These documents in the main present data that are a summary of points that I am presenting in this document. These summaries were related together, collated, refined and developed into an overall summary of points or characteristics. Selective coding was then used to identify core categories that would tie the other categories together. The final part of this phase of the overall study involved discriminate sampling, with deliberate and directed selection of persons, sites or documents to saturate any poorly developed categories to confirm and to build the categories and the theory as a whole into the 'big picture' theoretical model. Thus the frame of reference for the study and any alternative interpretation of discrepancies or conflicts is supported by attention to the social situation of the teaching/learning environment (Cohen & Manion, 1994).

4.5 DATA AND CATEGORIES

Sources of data were primarily books, journal articles, Internet websites and other publications in either printed or electronic media and many hundreds of resources were consulted. Although many resources did not significantly contribute to the range of the focus of the study, this in-depth consultation of resources uncovered a good number of documents that were worthy of consideration. This process of consultation of documents produced the data that in turn produced the categories in a similar manner to that if face-to-face interviews were able to be conducted with the writers themselves.

The categories are considered to be theoretical dense, either by virtue that they are explicitly stated in an authoritative document, through axial coding where several documents have been related and condensed, or through the results of surveys. A total of 34 categories were identified covering a range of inputs that directly or indirectly affect the area of teacher responsibility in the pursuit of developing a teaching/learning environment. This environment should encompass good adult teaching practice, provide an in-depth adult learning environment, employ assessment for learning as well as simultaneous competency-based and achievement-based assessment, and attempt to meet the demands from 'authoritative' sources. Each category consists of a number of principles that can be considered to be essential yet basic, and when combined, provide an integral category that promotes an in-depth summary.

4.6 THEORETICAL MODEL CATEGORIES

4.6.1 Analysis of Data

As set out in Chapter 1, the primary focus of this study was to try to find a way to meet the requirements of the simultaneous, dual assessment problems facing me as a teacher. In order to meet this focus, the investigation of literature evolved into a study of the relevant inputs into my teaching/learning environment. By conducting an in-depth study of the documented resources via grounded theory methodology, a theoretical model of the teaching/learning environment has been grounded in the data of the study. This in-depth study became invaluable in understanding the many and varied inputs that range from the restrictive to the empowering, the confusing to the innovative, and which result in feelings ranging from frustration to excitement.

This section presents an overview and discussion of the categories and some or all of their grounded propositions that were derived from the data. A selection of categories with the formal tabulation of propositions associated with each is included for the benefit of the reader in the Appendices to this report. For the purpose of this section, discussion of the major points of each category will proceed category by category to provide a more interpretable format for the reader while at the same time, highlight some of the difficulties presented to me in this study. The order in which the categories are discussed is in the groupings that were determined when the model was assembled. This has been done to assist the reader in relating where each category fits into the overall model.

The categories were initially sorted into two groups, those pertaining to the assessment framework and those pertaining to the learning environment. The number of categories in each group (or sub-group) is represented by the bracketed number.

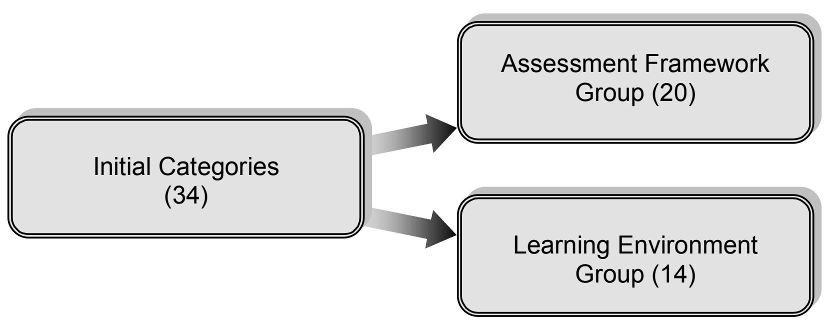

Figure 4.2. Initial sorting of categories

These two groups were further sorted into sub-groups.

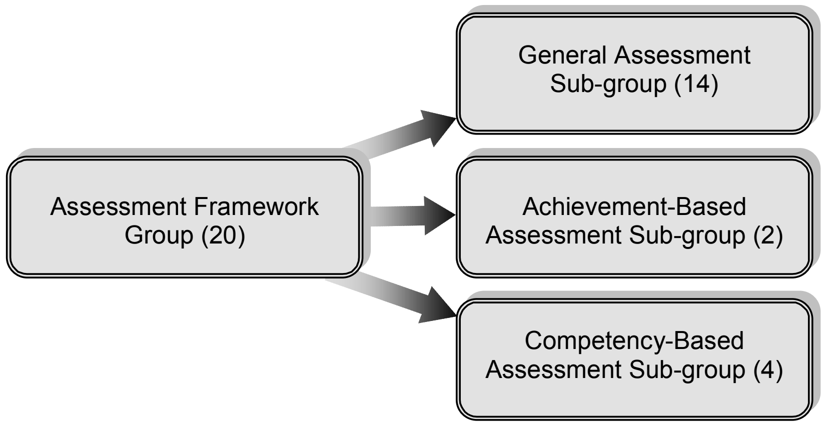

Figure 4.3. Sorting of assessment framework group of categories

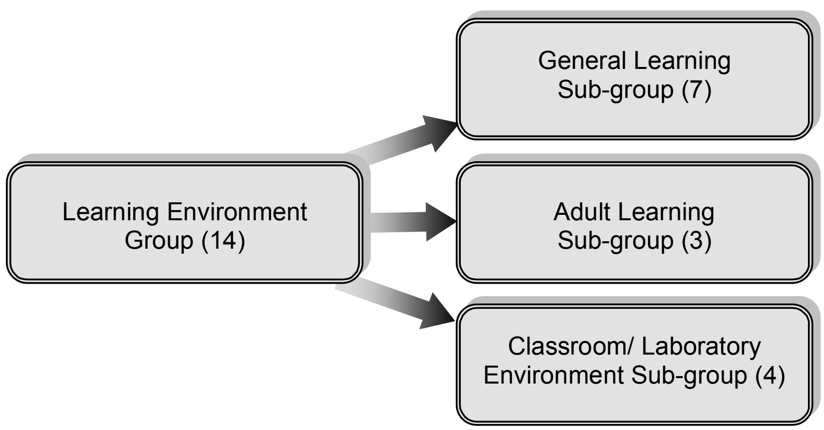

Figure 4.4. Sorting of learning environment group of categories

Discussion will follow the order of sub-groups…

- General Assessment Sub-group
- Achievement-Based Assessment Sub-group
- Competency-Based Assessment Sub-group

- General Learning Sub-group
- Adult Learning Sub-group
- Classroom/ Laboratory Environment Sub-group

4.6.2 General Assessment Sub-group

Category - Assessment for Learning

Extracts from *Assessment for Learning: Research-based principles to guide classroom practice* (Assessment Reform Group, 2002).

Assessment for Learning encompasses ten important principles:

- Assessment for learning should be part of effective planning of teaching and learning, provide opportunities for both learner and teacher to obtain and use information about progress towards learning goals. It will include strategies to ensure that learners understand the goals they are pursuing, and the criteria that will be applied in assessing their work. Planning will include how students will receive feedback, how they will take part in assessing their learning and how they will be helped to make further progress.
- Assessment for learning should focus on how students learn. Learners should become as aware of the 'how' of their learning as they are of the 'what'.
- Assessment for learning should be recognised as central to classroom practice. Much of what teachers and learners do in classrooms can be described as assessment. Assessment processes are an essential part of everyday classroom practice and involve both teachers and learners in reflection, dialogue and decision-making.
- Assessment for learning should be regarded as a key professional skill for teachers. Teachers require the professional knowledge and skills that need to be developed.
- Assessment for learning should be sensitive and constructive because any assessment has an emotional impact. Comments that focus on the work rather than the person are more constructive for both learning and motivation.

- Assessment should take account of the importance of learner motivation. Assessment methods should protect the learner's autonomy, provide some choice, provide constructive feedback, and create opportunity for self-direction. Assessment feedback should encourage learning and foster motivation by emphasising progress and achievement rather than failure.
- Assessment for learning should promote commitment to learning goals and a shared understanding of the criteria by which they are assessed.
- Learners should receive constructive guidance about how to improve, and information and guidance in order to plan the next steps in their learning.
- Assessment for learning develops learners' capacity for self-assessment so that they can become reflective and self-managing.
- Assessment for learning should recognise the full range of achievements of all learners. It should enable all learners to achieve their best and to have their efforts recognised.

Category - Assessment for Skills Development

Traditional learning and assessment methods have emphasized training in professional skills in undergraduate education in engineering, computer science and mathematics and not encouraged students to analyze, judge, communicate or discuss these skills. The use of examinations has actually inhibited the development of the students' independence and creativity and because an examination often consists of problems that the students solve individually, it is difficult to give complex and/or loosely defined problems in such an examination. This approach to learning has developed a surface approach where the student sees learning as a means to achieve an end. Students who see learning as a means to an end are motivated by an extrinsic objective and they will commit unrelated facts to their short term memory but are unlikely to be able to establish meaning or relationships between or within given tasks.

Increasing the students' involvement in, and responsibility for their studies, improving the students' communications skills, and strengthening the students' ability to think in abstract terms and to generalize, can develop the life and work skills of students. Further improvement in skills development can be obtained by encouraging the students to develop a creativity in their subjects and improving the their study habits.

Changing the learning environment and assessment method to student centred learning and authentic assessment, can positively influence the students' attitudes towards their studies, stimulate creativity and communication skills, prepare students for work in a changing world and for lifelong learning, and promote the creation of creative, adaptable students who are receptive to new situations. Students can be encouraged to develop a deep approach to learning, be personally involved in the task, seek to obtain some underlying meaning, and aim to understand relationships between the immediate task and other tasks or contexts. They will develop creativity, a better ability to think abstractly, the ability to generalize, and the ability to structure, all of which are important skills for engineering students. It will encourage students to read more extensively around a given topic, to discuss the topic and ultimately to achieve higher grades on assessment tasks than students who use a surface approach.

Category - Assessment Principles

Assessment should be an important part of education that is used for the enhancement of learning. It should clearly express and communicate the goals of the curriculum and be an integral component of the curriculum. When assessment is inextricably linked with the learning process, it will be a dynamic part of the teaching-learning process and motivate students to learn. In this way, assessment will reflect the quality and value of the total education and subject experiences and be a reflection of the richness of the learning process. Assessment can assist students and teachers as they accomplish their goals, it can assist the teacher to learn from the student's experience and it can assist teachers as they reflect upon the teaching-learning process, as well as the essence of the curriculum program at large. When assessment is part of the learning process, it will provide students with experiences that promote the how of scientific inquiry, rather than merely exposing them to what is known about and by science, and it will engage them in the kind of intellectually stimulating and invigorating assessments that further contribute to their understandings of science. Students will be encouraged to see their active engagement in the assessment process as a part of their involvement in learning. Assessment can provide feedback to enable students to improve their understanding, and diagnose misunderstandings to assist students to learn more effectively.

Assessment may be formative or summative. Formative assessment requires the student to recognise that there is a gap between their current understanding or skill level and the desired understanding or skill level, and then take effective action to close that gap. In order to do this they will need to understand both the process of formative feedback and how to apply this process to his or her work. Summative assessment, (which is an 'overview of previous learning') can be 'summing-up' which means creating a picture of achievement based on accumulating assessments that were originally formative, or 'checking-up' which means using tests or tasks at the end of learning that are assigned specifically to collect information for summative judgements.

Category - Assessment Towards In-Depth and Student-Centred Learning

To promote in-depth and student-centred learning, assessment should be designed to match the learning goals and identify if the chosen learning goal is being reached or satisfied and be associated with clearly promoted and established sets of criteria or rubrics to assess student work. It should include formative assessment to determine the learner's level of success in reaching the desired goal and also provide feedback to assist in this process. Self-assessment, which will allow students to evaluate their own participation, process and products, can also be provided. Summative assessment or achievement tests will help the instructor determine the level of achievement of an ability to carry out a given task and to determine the learner's level of proficiency.

Grading should be considered if it is necessary to indicate the degree of success of the student in the assigned task. This requires the inclusion of a process whereby the criteria of assessment and the final summative assessment in terms of marks are made very clear to both the students and the instructors.

Assessment for in-depth and student-centred learning can include short investigations (that assess how well students have mastered basic concepts and skills using words such as interpret, describe, calculate, explain, or predict), open-response questions (that present students with a stimulus and ask them to respond with a response such as a brief written or oral answer, a mathematical solution, a drawing, diagram, chart or graph) or portfolios (that document learning over time, promotes student improvement and teaches students the value of self-assessment, editing and revision).

Category - Authentic Assessment Principles

Authentic assessments are assessments that allow the use of alternative procedures to accommodate varied learning styles, multiple human judgements of learning, and present engaging and meaningful problems or tasks that are applicable to real-life contexts and situations that prepare students for the workforce. The curriculum is presented to students in the form of rich situational problems that helps them learn how to apply their skills to authentic tasks and projects. Authentic assessment requires students to understand the nature of high quality performance in a job related situation, conveying in their response that both development and achievement are important by placing an emphasis on the process and result. The assessment questions provide multistaged demonstrations of knowing, knowing why and knowing how, and require students to consider the task as a whole and not just simple elements, to reveal how they went about solving the task, not just provide the solution to the task. Questions should be adaptable, flexible, ongoing, and cumulative, and allow other learning opportunities to arise during assessment. A variety of items should be used to give students time to think, construct their own responses, demonstrate the depth of their knowledge and understanding, and solve problems in different ways and provide opportunities to measure students' productivity, performance and thinking. These items can be presented in rich, multidimensional, varied formats, both on-demand (in-class exercises) and cumulative (portfolios).

Authentic assessment should be carefully designed to have relevance to the curriculum and closely align the content and learning outcomes with the problems or tasks so that the assessment is not only derived from the curriculum but it is an integral part of teaching and of the feedback loop linked to the students' learning. The assessment becomes part of a learning environment that promotes thinking and reasoning skills, allows students to work individually or in small groups, and develop attitudes and dispositions such as persistence, reflection, participation and enthusiasm. It will encourage learners to demonstrate a diverse understanding of what they have learnt and can do, so that they can see the growth of their learning over time. The scoring procedures should communicate to the students awareness and fairness through clear, concise, and openly communicated standards of assessment processes and encourage them to take ownership of their learning. Opportunities should be provided for learner self-evaluation, feedback to themselves and to others, and the focus should be on students' conceptual insights and analytical skills, their ability to integrate what they learn, their creativity and ability to work collaboratively, and their written and oral expression skills. Students are helped through this authentic assessment to develop skills that will cope with ambiguity, to perceive patterns and to solve unconventional problems. A range of opportunities can be provided for individual performance as well as group work.

Category - Creating Meaningful Performance Assessments

Performance assessment may be defined as a method of assessment that requires students to create an answer or perform an exercise that demonstrates their knowledge and skills such as doing mathematical calculations, conducting experiments, writing extended essays, etc. This type of assessment is best understood as a continuous sequence of formats ranging from simple student-constructed responses to comprehensive demonstrations or collections of work over a period of time. The terms 'performance' (the generation of a response by a student that is observed either directly or indirectly) and 'authentic' (where the task and the context in which the assessment occurs is relevant and represents "real world" problems or issues) are used in conjunction with assessment to measure what is taught in the curriculum.

Performance assessments should measure important learning outcomes, motivate high performance and require the demonstration of complex understanding and thinking applicable to important problem areas. The assessment should focus on reflecting what is taught and how it is taught through a series of theoretically and practically coherent learning activities that mirror the learning objectives and expected student outcomes. The assessment should interact with instruction that precedes and follows an assessment task, and it must be associated with typical examples of current standards or quality of subject matter. Items should contain written and oral explanations of tasks that are clear and concise and presented in language that the students understand, and be associated with the appropriate tools that need to be available to support the completion of the assessment activity.

Self-assessment is promoted when the scoring criteria are well articulated and this can be part of the provision of formative feedback to the students to assist with remedial assistance. Thus the provision of clear indicators of student performance that can be linked to instructional actions is essential and this is compatible with a variety of instructional models. The assessment must be easily administered, scored, and interpreted by teachers, communicate the goals of learning to teachers and students, and generate accurate, meaningful information (i.e., be reliable and valid).

Category - Fair Assessment

Fair assessment practices can be promoted by having clearly stated learning outcomes that match the assessment to what is taught (i.e. the curriculum). The use of many different measures and many different kinds of measures can also promote fairness, as does helping students learn how to do the assessment task by providing clear instructions and good examples. Engaging and encouraging students in their performance, the inclusion of appropriate interpretation of assessment results and providing feedback that will improve the students' learning, also promote fairness in assessment.

Category - Good Practice Assessment Principles

A set of principles of good practice for assessing student learning include the premise that assessment of student learning begins with educational values and it is most effective when it reflects an understanding of learning as multidimensional, integrated and revealed in performance over time. Assessment will work best when the programs it seeks to improve have clear, explicitly stated purposes that in turn provide the focus that assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes. Assessment needs to be ongoing and not episodic and it does make a difference when it begins with issues of use and illuminates questions that people really do care about. Good assessment will foster wider improvement when representatives from across the educational community are involved and will most likely lead to improvement when it is part of a larger set of conditions that promote change. Through assessment, educators meet responsibilities to students and to the public.

Category - Learning Goals and Outcomes

The statement of goals and the accompanying learning outcomes are essential to provide a clear focus for both instruction and assessment. Both goals and outcomes should reflect knowledge and information that is worthwhile for students to learn and the relationship between a given goal and the outcomes that describe that goal should be apparent. All of the important aspects of the given goal should be reflected through the outcomes, which in turn should describe measurable student outcomes.

Learning outcomes (which are also known as behavioural objectives, learning objectives, instructional objectives or performance objectives) are terms that refer to descriptions of observable student behaviour or performance that are used to make judgements about learning. These outcomes have three essential parts; the condition that describes the conditions (i.e. the circumstances, commands, materials, directions, etc.) under which the behaviour is to be performed, the behavioural verb that is the action word that suggests an observable feature of the students' performance, and the criteria that is a statement that specifies how well the student must perform the task.

Learning outcomes should serve to clarify the purposes and intent of instruction for teachers and students, and communicate to the students in a consistent, orderly and efficient manner what they are to learn. They provide the basis for lesson planning, focus the attention of the teacher on student learning and the design of their classroom instructional events to provide on-target instructional activities and promote students' mastery of the outcomes. Well-defined outcomes will promote the teacher's understanding of the end point of instruction and the relevance of their explanations, modelling, and practice activities. Most important for the teacher, outcomes will empower teachers to evaluate whether their instructional efforts have been effective and that learning has taken place, instead of merely dishing out instruction and hoping for the best. Outcomes should be associated with clearly defined assessment instruments to determine whether the outcomes have actually been achieved.

Category - MYTEC Academic Regulations

The assessment section of the institution's academic regulations that were effective in 2003 contains 'inputs' which impact into the teacher's domain. In general, "the performance of each student enrolled for a course will be assessed on the basis of such examinations, tests and other course work as set out by the examiners" and "written advice regarding the methods of assessment, the due dates for any piece of course work or assessment which will contribute to the final grade, and the relative value of each piece of work or assessment will be provided by the department for enrolled students by the end of the first week of classes". This statement then refers through the phrase "assessment which will contribute to the final grade" to achievement-based assessment only. However under 'Mixed Mode Assessment', we find "courses incorporating mixed mode assessment must clearly state the requirements for completion of competencies and communicate these to students". Thus the teacher is required to present in written form the assessment plan for all assessment at the beginning of each course. In regards to mixed mode assessment, we find "courses may provide for both competency and achievement based assessment and be approved through the normal quality assurance processes" and "where both types of assessment are incorporated in a course, the final result recorded on the OASIS and official result notice will be the achievement result/grade". If a course is partially or completely grounded in a unit standard, then "The unit standard results which form part of the competency assessment will appear on the unofficial academic status report of units and will be sent to NZQA for NZQA's Record of Learning". Thus the academic regulations reflected an institution's management interest in recording in the institution's computer system, a student's achievement mark or grade and not their competency assessment results. From a teacher and student perspective, the answer to such a peculiarity of differentiating student's learning achievements and recognising some but not others, can be found in the MYTEC Assessment Policy… "In summary, the assessment procedures used by this institution (and its constituent Faculties and Departments) are the procedures by which accountability can be demonstrated to students, management and wider public”. My interpretation is that the policies and concern of management is assessment for accountability, not assessment for learning or assessment of learning. Thus the focus is not on student learning and is in direct conflict to TEAC’s conclusion 3. Nor is it in keeping with virtually all other articles or studies on assessment. This conflict produced in me a sense of frustration of not having management support in the attempt to do what was expected of me to produce and implement the dual assessment system in the best interests of students’ learning.

A teacher must also allow in their assessment framework the “Reconsideration of marks and grades” where “A student may formally apply to have the mark awarded to a test, examination or any piece of course work reconsidered” or “A student may apply to have the final grade for the course reconsidered”.

In the section on Grades and results, “For courses in which a competency based learning system is operated, results may be specified as follows”:

Table 4.6

Specification of Marks for a Competency Based Learning System.

M	Merit pass
P	Pass
I	Incomplete (where a student has attempted the assessment but has not passed)
DNC	Did not complete (where a student has not attempted the assessment)

And “For achievement based courses in which results are determined on the basis of summative assessment, grades may be allocated according to the level of achievement, in which case results will normally be specified in the following terms:” A, B, C, D, or E, or in an alternative form, A++, A+, A, A–, B+, B, B–, C+, C, D, or E. There is no clear direction as to which form of grade to use.

Table 4.7

Specification of Marks for an Achievement Based Learning System.

Mark (%)	Grade	Alternatives	Result	Explanation
90–100 85–89 80–84 75–79	)) A))	A++ A+ A A–	)) Pass))	Distinction
70–74 65–69 60–64	)) B)	B+ B B–	)) Pass)	Credit
55–59 50–54	) C)	C+ C	) Pass)	Pass
40–49 0–39	D E	D E	) Fail)	Fail

Category - MYTEC Assessment Policy

The introduction to the MYTEC assessment policy that was effective in 2003 states “Assessment is an integral part of the teaching and learning processes which this institution uses to deliver its programmes and courses”. “Assessment can be used for a number of purposes; it can be used directly as a basis of reporting on general standards in a programme, to determine those who pass in a particular programme or course, and to determine the extent to which course objectives have been met”. “It can be used indirectly to provide staff with ‘feedback’ on the quality of their teaching to establish the quality of the programmes/ courses being offered within a Department”. It then concludes the introduction with the statement mentioned previously; “In summary, the assessment procedures used by this institution (and its constituent Faculties and Departments) are the procedures by which accountability can be demonstrated to students, management and wider public". The only inference to students is that assessment can be used "to determine those who pass in a particular programme or course".

The "Principles and Guidelines" section of the assessment policy does however provide more focus on the student and addresses both the formative and summative requirements of programmes and courses. Here we find directives for teachers under the umbrella expression "In developing assessment requirements teaching staff should" followed by seven principles. The first three, "make assessment procedures as valid and reliable as possible", "make assessment tasks relate to the wider context in which knowledge, skills and values have application and relevance" and "make assessment tasks focus on the processes students use as well as the outcomes to be achieved" are clearly directives for the teacher to implement within the assessment plan. The next three "allow for students to respond in a number of ways - where that is practical", "allow for students to respond as a group and not only as individuals - a group project can be part of an assessment schedule for a course or programme" and "make assessment tasks challenge the student's levels of thinking - with higher level programmes and courses, assessment must require higher level student responses appropriate to the programme", are good general assessment principles. The last principle "relate students' assessment performances to the establishment or redefinition of learning outcomes" is somewhat confusing as it suggests that student assessment performance should be linked to the establishment of learning outcomes or the redefinition of learning outcomes. In other words, learning outcomes are dependant on student performance. Other categories of data clearly demonstrate the importance of relating students' assessment performances to the established and well defined learning outcomes of the course.

Competency Based Assessment is "where a particular standard is set which candidates must reach if they are to be judged as 'competent', and therefore receive credit. Competency based assessment does not lead to the awarding of a grade. The standard here then, is a criterion level in specified skills or areas of knowledge".

Formative Assessment "will occur primarily for giving feedback to students in both theoretical and practical components of a programme. In addition, formative assessment can identify the progress of the learning process and alternative measures that need to be taken to improve the teaching and learning processes. Formative assessment must be clearly differentiated from summative assessment. Formative assessments are not used for grading students. Assessment protocols must clearly distinguish formative assessments from summative assessments". Summative Assessments or Grades "contribute to the total result awarded to a student on completion of a course, as a measure of performance in the course as a whole. Summative Assessments will relate to learning outcomes which will be clearly stated in the programme/course outline".

The query here is what exactly differentiates formative assessment from summative assessment. A test at the end of part of the course instruction given with the objective of creating marks that contribute to the final mark would be considered summative. However, if the marked test paper were handed back to the students together with a marking schedule so that they could learn from the mistakes before sitting the final examination, it would then be considered formative assessment. The argument for this is based on the fact that the assessment provides the student with valuable information about how well they are progressing towards the program's expectations, a definition of formative assessment (Maki, 2004). If this argument is supported, then under the directives of the academic regulations, the test cannot be used to contribute marks towards the final course mark or grade even though tests are weighted as 20% of the final mark. This is an example of the problems facing a teacher.

Category - Planning and Developing Assessment

The planning and development of assessment should start with the development of the framework for the assessment. This framework serves as the guide to the entire assessment and consists primarily of the course and lesson objectives set out to ensure that each is assessed.

Steps for the development of performance assessments include identifying goals and course outcomes, identifying specific learning objective(s) for each broad goal and the development of performance criterion(s) for each learning objective.

Assessment plans have three components. There is a statement of educational goals that define exactly what is expected of students, a valid set of assessment instruments that provide a means to achieve multiple measures of student achievement of the goals, and a feedback path so that the resulting performance information can be used to improve both teaching and student performance.

The assessment plan is developed from the assessment framework and is used to provide an overview of the types of assessment to be developed and used. In addition it will describe the types of assessments that are to be used and how assessments will be administered, scored, and reported.

The assessment design will describe the characteristics of an adequate assessment for each content area of the assessment framework and should guide the development of the assessment instruments for each objective that are needed in keeping with the available resources. Assessment design should include means for feedback to the student and evaluation of whether the performance criteria were met and the objectives achieved. Marking schedules and/or criteria are used to assess student responses and these include samples of how the students could respond and how such responses will be recorded and scored.

Category - Scoring Rubrics

Performance rubrics have two common features, a list of criteria and graduations of quality. They provide a means to assess postsecondary academic skills on the basis of such a scale that presents a continuum of performance levels defined in terms of selected criteria, towards the full attainment or development of the targeted skills.

They provide a framework that helps assessors to be consistent, focuses the attention of assessor and the assessed on important outcomes, and establishes benchmarks for documenting progress. Rubrics feature a rating scale based on a stated standard, objective, behaviour, or quality that assists teachers to evaluate papers or projects because they know what makes a good final product and why. This makes the assessment of student work quick and efficient. They are teaching tools that support student learning, the development of thinking skills, and they help students to understand how they will be evaluated so they can prepare accordingly. Rubrics provide a grid of criteria necessary to improve students' work and increase their knowledge and guide students to build on existing knowledge. Well-defined performance levels allow students to reflect on and reveal problems that will be more informative than vague levels of quality or a simple numeric mark. In this way, they help to improve students' end products and therefore increase learning.

Rubrics are more likely to provide qualitative, meaningful, and stable appraisals than traditional scoring methods. They are easy to use and explain, they are concise and digestible, they are transparent to students, and they make teacher's expectations very clear. Through the use of rubrics, students are provided with more informative feedback about their strengths and areas in need of improvement than traditional forms of assessment. With this approach, they help students learn in a way that they cannot learn from a mark and therefore they support the development of good thinking, skills and understanding.

The use of the scale involves the acts of scoring (which occurs when one identifies, within the scale, and for each criterion, the cell description that most closely matches the observed performance), interpretation (which consists of locating the column that best describes the level of skill mastery), and judging (which is the means of comparing the identified or observed performance level to a predetermined standard level).

Category - Validity Promoting Assessment Procedures

In order to promote the validity of competency-based assessment, it is important that the person doing the assessing must have been trained to develop the necessary skills to be a competent assessor, and consider the following criteria.

The assessment instruments, taken as a whole, should require a student to perform to an acceptable level, manage a number of different tasks within the job, and respond appropriately to unexpected events. Students should be able to work with others or as part of a team, and be able to use skills learnt in one situation in a new or different context. Assessment tasks should not promote the development of rote learning but rather develop the application of thinking skills such as critical thinking to solve problems. Assessment instruments and procedures should be cost-effective.

All performance criteria in the industry standards should be matched by tasks and questions in the assessment instruments and it is important to ensure that essential criteria are demonstrated. The various written, oral, practical and/or workplace components of assessments should be consistent with one another. There should be a clear relationship between the students' or trainees' outcomes from the assessments and their performance at work or in further learning they undertake.

There should be a degree of confidence that other assessors working in the same area would independently come to the same conclusions about a student's or trainee's performance and there should be a degree of confidence that if a student or trainee were assessed to the same performance criteria on two separate occasions, (e.g., one week apart) and without further training, the assessment result would be the same. Also the outcomes of assessments should be consistent with evidence from other sources. Also the trainee's sex, ethnicity or socio-economic status should not influence the results of an assessment and the way in which the results of an assessment are used should not lead to any inappropriate social consequences for the student or trainee.

Summary of General Assessment Sub-Group

The following categories were discussed in this sub-group…

Table 4.8

Categories Associated with the General Assessment Sub-Group

Assessment for Learning Assessment for Skills Development Assessment Principles Assessment Towards In-Depth and Student-Centred Learning Authentic Assessment Principles Creating Meaningful Performance Assessments Fair Assessment Good Practice Assessment Principles Learning Goals and Outcomes MYTEC Academic Regulations MYTEC Assessment Policy Planning and Developing Assessment Scoring Rubrics Validity Promoting Assessment Procedures	General Assessment Sub-Group

4.6.3 Achievement-Based Assessment Sub-group

Category - Achievement-Based Assessment: NZQA

'To Your Marks!' contains advice to teachers and tutors on setting and marking assessments (New Zealand Qualifications Authority, 1997), and is a document that was 'uncovered' during the process of searching for data during the initial phase of attempting to find information that would help with the simultaneous dual assessment problem. It "offers practical advice to tutors, teachers and lecturers on setting and marking examinations", and "the intention of this booklet is simply to offer accessible, easily read, practical advice to tutors". It "offers suggestions about assessments that can produce ‘marks’, whether or not the assessment is against explicit criteria” and focuses on “assessments in which the student is set a written task that is then marked for purposes established by the teaching institution”. For convenience “these assessments are referred to as ‘examinations’”.

A good examination “is a fair and valid assessment of students’ knowledge, understanding and abilities in relation to the expected learning outcomes of the course prescription or course statement”. It will give “students ample opportunity to show what they know and can do rather than reveal what they do not know or cannot do” and “adheres to any requirements specified in the course prescription or course statement”. It will be “clear, ambiguous and error free”, “well balanced in terms of time allocation and mark allocation”, and be “accompanied by a good marking schedule”.

A good marking schedule “reflects the expected learning outcomes of the course prescription or course statement”, “gives the main points required in students’ answers and acceptable alternatives”, and “shows any calculations required”. It will also show “clearly how marks are allocated within each question and what students need to do in order to earn these marks”, assist “the marker in making judgements on whether or not students’ answers will be awarded the specified marks”, and it “should be prepared at the same time as the examination is being set”.

“At the time examination questions are being formulated, thought needs to be given to the answers that are required or that students may give. Careful wording of questions can make it easier for students to interpret what is required and can also make for more systematic marking. The ‘size’ of the answer expected should be considered in allocating marks for the question”.

Some of the characteristics that examination questions should have are factual correctness, a style that is clear which leaves the “students in no doubt as to the intention”, short sentences, technical terms that conform to current usage, clear information for a question, a correlation between the allocated marks and the time required to answer the question, and the importance of the topic.

In summary this is a good example of good data for the teacher.

Category - Diploma in Technology Curriculum Document

The following are relevant extracts from the *Diploma in Technology Curriculum Document* that was effective in 2003 and these statements relate directly to the Dip Tech programme and the constituent courses.

The general aim and qualities of assessment as stated in the Diploma in Technology Curriculum Document are that "Assessment is an integral part of the teaching and learning processes, which are used to deliver the courses in the programme. Students are assessed according to the learning outcomes and performance criteria outlined for each course. Assessments aim to be a positive process enabling students to meet the learning outcomes of the programme". "The system of assessment will be 'Mixed Mode', a combination of both competency-based and graded assessments".

"Methods of assessment vary from course to course and are detailed in the Course Descriptors (Endorsement Documents). The weighting for graded assessments varies according to each course. The weighting of marks for each piece of assessment in a course is detailed in Course Handbooks issued to students prior to the start of the course". An example for the Direct Current Circuits course is, assignments and laboratories (20%), tests (20%) and examination (60%).

"Grades will be used for assessments such as exams, assignments, presentations and laboratories. Assessment marks are weighted and summed to provide an overall percentage mark which is translated into a grade according to MYTEC Academic Regulations". There is a small problem here in that Grades are given as A-E and are not marks. Therefore "The approval of grades is the responsibility of Faculty Boards of Studies, which will advise Academic Registry to release the results", and are not of the teacher. The instruction to the teacher is that grades are to be used for individual assessment yet marks are to be summed to produce the overall grade, which is then approved.

“For assessments that are competency based, weighting does not apply. To receive a pass in competency based courses, students must demonstrate competence in the performance criteria listed in the Course Descriptors and detailed in the Course Handbook. Courses incorporating mixed-mode assessment must clearly state the requirements for completion of unit standard competency and communicate these to students in course handbooks”.

The general aim and qualities of assessment section states that “The assessment methods will be appropriate, fair, reliable, manageable and, wherever possible, integrated with learning/work. The evidence collected during assessment will be valid, direct, sufficient and authentic. The assessment judgements will be consistent, open and credible. Tutors are responsible for ensuring these assessment qualities”.

This responsibility is repeated again in the section on assessment schedules; “The tutor delivering the course is responsible for assessments, scheduling of assessments, resits and result-reporting”. Teachers are also required to communicate assessment information to the students – “The proposed dates and schedules of assessments together with the specific nature and scope of requirements for assessments will be included in course detail documents provided to students at the start of each course”.

Another responsibility is placed on the teacher under the Policy and Procedure for Reassessments: Reassessment of Competency section. “For practical reasons, students who do not meet the expected level of competence at the first assessment will be generally offered one reassessment per competency task. However, one more opportunity may be offered, at the discretion of an academic staff member” (or teacher).

The resource requirements, specifications and list of staff section requires the teacher to be able to "Maintain up-to-date knowledge and practice in the field and relate this to teaching and learning", "Plan, prepare and deliver content/subject matter using a variety of effective teaching strategies", and "Ensure assessment, moderation and evaluation processes are carried out effectively as required". The only requirements necessary for a teacher to meet these responsibilities for planning, preparing and delivering the content/subject matter, effective assessment, etc, is that the teacher (the academic staff member or ASM) must have a tertiary qualification, professional industry experience and possess teaching experience in one of the major disciplines. While this provision looks good on paper, the reality is that 'teaching experience' has little meaning in light of the responsibilities and for myself, very little professional development was made available over 33 years to give guidance on how to meet these responsibilities.

Summary of Achievement-Based Assessment Sub-group

The following categories were discussed in this sub-group…

Table 4.9

Categories Associated with the Achievement-Based Assessment Sub-group

Achievement-Based Assessment: NZQA	Achievement-Based Assessment Sub-group
Diploma in Technology Curriculum Document	

4.6.4 Competency-Based Assessment Sub-group

Category - Assessment for the NQF: NZQA

In 2001, NZQA produced a book 'Learning and assessment: A guide to assessment for the national qualifications framework' (New Zealand Qualifications Authority, 2001). This book is a guide for tutors, teachers, trainers, lecturers and assessors that explores the basic thinking and principles underlying assessment for the National Qualifications Framework (NQF).

The purpose of assessment for the Qualifications Framework "is to ascertain whether or not students have achieved the level of performance required by the unit standard". In order to meet this purpose it is necessary to collect evidence so the book considers "What is evidence and how is it collected?", that "Written examinations and tests are sources of evidence" and "The need to limit time and access to resources means that written answers might provide evidence about writing skills or memory, rather than depth of knowledge or understanding".

The Qualifications Framework approach to evidence is that it is multisourced, on-going, comes from well-designed learning activities, and includes improvement of performance. Evidence can come from a variety of sources, including examinations and tests and can be collected along the way, not just in a final test. Assessment activities can be consistent with the style of learning and as such, normal learning activities should be designed to provide opportunities for students to produce direct and valid evidence.

There are three approaches to the evaluation of evidence; evaluation against own previous achievements, comparison with a pre-determined standard, or comparison with the achievements of others. Where a learner's evidence is evaluated against their own previous achievements, it is termed self-referenced assessment and is used to show how much progress students have made over time. When a learner's evidence is compared with a pre-determined standard, it is termed criterion-referenced or standards-based assessment and this is helpful in describing student abilities and providing clear learning targets. The term norm-referenced assessment is used when each learner's evidence is compared with the achievements of others. This is helpful when there is a need to rank students or to sort them for selection.

The Qualifications Framework uses a form of standards-based assessment where evidence is compared with the criteria at a pre-determined standard. The criteria are expressed in a format called unit standards and are interpreted with the aid of external moderation. Evidence is evaluated against the written criteria and either the evidence meets the criteria in the unit standard or not. Everyone who reaches the standard gets the credit.

Good assessment should be student focused, integrated with learning and be manageable. Assessment methods will be appropriate, fair, integrated with work or learning, and manageable. Evidence will be valid, direct, authentic and sufficient and assessment will be systematic, open and consistent.

When collecting evidence, there is the need to evaluate the evidence and ask the following questions. Is the evidence worth considering? Is the evidence authentic and valid, and if so, then does the evidence indicate that the standard has been achieved? Does the evidence meet the performance criteria that is published as the benchmark to judge whether the evidence meets the required standard? Are all the performance criteria covered to the required standard and is the evidence consistent and sufficient?

Once suitable opportunities during the learning programme when evidence can be collected are identified, the assessment plan can be drawn up. This should record when and how the evidence is to be collected and the methods that are planned to do this. The plan should also allow for reassessment and/or provision of further evidence and potential for individual variations.

Table 4.10

NZQA's Recommended Steps to Creating an Assessment Plan

Steps to creating an assessment plan
▪ Plan your learning programme to suit your students, your resources, and selected qualifications and/or curriculum statements.
▪ Identify unit standards that are consistent with the content and objectives of the programme.
▪ Modify your learning programme if necessary to accommodate selected unit standards.
▪ Sketch out the learning activities you will use to suit the aims and style of the learning programme.
▪ Look into the unit standards for evidence requirements and implied sources of evidence.
▪ Identify evidence opportunities — see how much of the required evidence can come from the learning activities you have planned.
▪ Match this evidence with the requirements of unit standards —what other evidence do you need?
▪ Fine tune some of the learning activities and/or plan assessment tasks that will provide evidence at the appropriate points in the learning programme.
▪ Consider how external moderation requirements impact on your plans and make adjustments as necessary.
▪ Consider how further evidence (reassessment) opportunities can be provided.
▪ Consider how individuals could progress at different rates —aiming at fewer or more unit standards.
▪ Design the details of learning activities and assessment tasks so that they provide suitable evidence and meet criteria for good assessment.
▪ Plan how you will record progress towards credit as evidence is accumulated.

Category - Assessment of Unit Standards: NZQA

Guidelines to assessment of Unit Standards were first developed by The Association of Polytechnics in New Zealand (APNZ) and the Industry Training Federation (ITF), and produced in 2000 as Best Practice in the Assessment of Unit Standards. The New Zealand Qualifications Authority (NZQA) reviewed the document in 2003 and after public consultation which resulted in no major changes to the body of the consultation document, published the revised version in 2005. Most consultation suggestions were incorporated as further 'questions and answers' in the appendix. NZQA has tried to ensure that while the statements are written in terms of assessment against unit standards, the principles and underlying concepts are transferable to other forms of standards-based assessment. The latest version is 'Best practice assessment principles for the assessment of unit standards' (New Zealand Qualifications Authority, 2005).

There are two principles of best practice assessment, assessment design and assessment decisions.

Principle 1: Assessment Design states "Best practice assessment will occur when the assessor focuses on elements, and gives due consideration to all performance criteria within the unit standard(s)". The concepts underpinning this principle are that unit standards are statements of what a person knows and/or can do, expressed as outcomes. The element(s) in the standard identify the outcomes against which the candidate is assessed. All the contexts specified in a range statement must be considered when making an assessment decision unless they are elective within a range statement (e.g., "may include but not limited to"). Performance criteria are associated with elements but they do not express outcomes. Rather they indicate the minimum evidence to consider when making a judgement as to whether the candidate has achieved the outcomes of the element and, therefore, the standard. Sufficiency of evidence should be described in the assessment schedule. Assessment(s), and the basis for making assessment decisions, must be designed to be consistent with the unit standard and should be designed to focus on the wholeness of performance against the outcomes identified in the elements. Assessment(s) designed for individual performance criteria may lead to over-assessment. Assessment of related or similar learning outcomes should be integrated, where possible and be designed to ensure that the candidate has adequate opportunity to meet the requirements of the unit standard. Assessment(s) also must include an assessment schedule clearly showing the evidence the candidate is expected to provide, and the basis on which assessment decisions are to be made.

Principle 2: Assessment Decisions states "Best practice assessment will occur when the assessor judges, overall, that the candidate has provided sufficient evidence that the outcomes, identified in the elements, have been met". The concepts underpinning this principle are that performance criteria are critical guidelines to the type of evidence that must be collected to make a judgement about performance. In making an assessment decision, sufficient evidence must be provided so that the assessor is confident that the candidate can do what the standard requires. This evidence can be drawn from a range of sources, for example, set tasks, naturally occurring evidence, recognition of prior learning (RPL) and recognition of current competency (RCC). The key question must always be, "Is the assessor confident the candidate knows or can currently do what is required by the standard(s) being assessed?" Assessment decisions will be consistent with, and at, the national standard when they are based solely on the requirements of the standard. Any assessment decisions based on consideration of only some of the performance criteria will lead to assessment that is not at the national standard. Therefore the assessment judgement must consider all matters in the performance criteria of each element and the assessment should be designed to efficiently provide the required evidence. The use of exemplars, discussions with other assessors and moderation processes will assist assessors in making consistent judgements as to whether there is sufficient evidence of competence.

Assessment against unit standards measures competency against a stated (national) standard. Over-assessment occurs when the candidate is required to produce more than sufficient evidence to demonstrate competency. For example, repeated performance of the same skill or knowledge or more demonstrations of a skill or knowledge than is stated in the standard. Avoid over-assessment such as this as it leads to frustration for candidates, assessors and trainers.

Category - ElectroTechnology Industry Training Organisation

The ElectroTechnology Industry Training Organisation (ETITO) is responsible for the NDE and the registration of the associated unit standards on the National Qualifications Framework. As part of that responsibility, a centrally established and directed national moderation system has been set up by the ETITO and there is a set of guiding principles that govern the ETITO moderation strategy. These include ensuring that assessment is fair, valid and consistent, and that assessment meets the nationally prescribed unit standards. To do this, the purpose of a moderation system is to detect variance from the standard and to keep the variance to a minimum. The moderation system should include a process for moderating judgements and monitoring assessment systems and processes, and it should suit the culture of the particular industry sector. It should also include systems and processes that support 'best practice' in assessment that include using an integrated method of assessment based around a collection of evidence model, and include systems and processes that protect the quality and credibility of industry qualifications.

Category - Principles of Standards-Based Assessment

Beyond the norm? An introduction to standards-based assessment (Peddie, 1992), is a book or manual written as an introduction to assessment and in particular, to standards-based assessment and units registered on the Qualifications Framework. At the beginning of the book in Chapter 2 'Some Statements About Assessment' (pp. 6-9) are 12 important statements that should be considered carefully by teachers developing assessment programmes. Although I sense that the focus is more towards assessment of learning and not assessment for learning, this list of statements focuses the teacher on the needs of students and not on accountability.

Table 4.11

Recommended Thoughts for Focusing Assessment on the Needs of Students

1	Assessments should be as fair, accurate and appropriate as possible.
2	A good assessment programme is always an integral part of a good curriculum.
3	A good assessment programme should encourage and assist learners.
4	Most assessments involve value judgements and are intertwined with ethical issues.
5	Assessment programmes should be as unbiased as possible. In particular, they should not be biased against identifiable groups in the community.
6	Teachers should be aware as possible of what comparisons and standards are involved in their assessments.
7	Assessment implies some form of subjective analysis or judgement, both at the time of preparing the tests or measures to be used, and after results have been obtained.
8	Decisions about 'passing' and 'failing' almost always involve arbitrary and subjective judgements.
9	Assessment can be used for a number of different purposes. Some approaches to assessment suit some purposes better than others.
10	There are ways of deciding whether particular tests or ways of measuring are 'better' or 'worse' than others.
11	The 'technical bits' of assessment do make a difference.
12	Even experienced assessment specialists need to go back to basics every time they are involved in developing a new assessment programme.

Summary of Competency-Based Assessment Sub-group

The following categories were discussed in this sub-group…

Table 4.12

Categories Associated with the Competency-Based Assessment Sub-group

Assessment for the NQF: NZQA	Competency-Based Assessment Sub-group
Assessment of Unit Standards: NZQA	
ElectroTechnology Industry Training Organisation	
Principles of Standards-Based Assessment	

4.6.5 General Learning Sub-group

Category - Collaborative Learning

Collaborative learning, cooperative learning, peer learning and group learning are terms that are interchangeably used to define an instruction method that encourages students to work together in small groups toward a common goal such as the accomplishment of an educational task. This approach usually provides a more comfortable atmosphere for minority groups such as overseas, female and mature students, and promotes the improvement in communication skills as students are given an opportunity to express their thoughts openly. Study groups provide the students with real life experiences that could be utilized in their upcoming career and allows for critical-thinking items that involve analysis, synthesis, and evaluation of the concepts. Working in collaborative learning groups requires the teacher to act as a facilitator of learning, not a giver of information.

Through collaborative learning, students' critical thinking skills and problem-solving strategies are improved. The group activities elicit reasons from students for their judgements and decisions and this helps in the understanding process and in the encouraging of helpful feedback. Student knowledge and experience is pooled and this provides new perspectives. Collaborative learning requires greater responsibility for self and the group and this contributes positively to the learning process especially when there is diversity in the group.

Category - Competency-Based Education

Competency-based education (CBE) is also known as outcome-based education and specifies the outcomes students should be able to demonstrate upon completion of their studies. The term competency is used to mean the ability of a student to utilise their knowledge, skills, capabilities, attitudes and behaviours in order to perform a task according to the specified level of competency, i.e. the required standard of performance. CBE recognises that competency cannot be directly observed but rather it is a transparent concept that can be observed in a given context of validated behaviours that the student can demonstrate. The focus is on educational practice that ensures that students have the opportunity to master the specified outcomes. CBE concentrates on students graduating having demonstrated mastery of the whole of a defined set of competencies rather than a graduation based on an accumulated grade, and which, quite probably, is one that has demonstrated a knowledge which is strong in one section and weak in another.

There are two requirements for CBE. Firstly the learning outcomes must be identified, made explicit and communicated to all concerned, (students, teachers and employers) and secondly that these outcomes should be the focus of educational decisions. This in turn requires that the educational outcomes be clearly and unambiguously specified, and that learning activities should be considered in terms of its expected outcomes. CBE provides a much wider education focus on the use of skills rather than just knowledge or skill acquisition and requires a student to acquire knowledge, be able to use it efficiently and to transfer it to other situations. This type of approach to learning offers a powerful tool for modifying, designing, managing and evaluating engineering curricula and facilitates the learning towards active learning rather than passive learning. It encourages students to take more responsibility for their own learning and it helps to integrate technical content with foundation skills in the teaching/learning process.

CBE provides realistic applications and the portability of skills across experiences, and increases relevance for learners and it provides tools for curriculum evaluation and improvement. Finally, it requires teachers have a detailed understanding of their own contribution to the curriculum as facilitators as well as teachers.

CBE assessment plans have a clear statement of educational goals in order to define exactly what is expected of students. It requires a valid set of assessment instruments in order to achieve multiple measures of student achievement of the goals, and a feedback path so that the resulting performance information can be used to improve teaching and student performance.

Category - Designing a Competency-Based Curriculum

When designing a competency-based curriculum, the following design suggestions will promote a clear and unambiguous framework for curriculum planning.

Competencies produce a clear statement of the competencies to be demonstrated by each student upon graduation. Avoid a long list of competencies because they become unmanageable and hard to apply in practice. Express competencies so that they are broad in their vision yet specific enough to be focused on and measured effectively.

Assessment should be developed for each activity according to the desired level of performance with the focus on determining whether the learner has met the specified level of performance. This focus will require that the criteria and conditions by which performance will be assessed, be explicitly stated. CBE will encourage the development of non-traditional assessment techniques.

A curriculum map is used to formulate individual learning activities from learning outcomes and assigns responsibility to the learning and performance tasks where the competencies will be addressed. It will sequence competency performances based on a logical and gradual mastery of skills, up to the level of performance required by the course standard.

Learning activities focus on the specific design of each learning activity and describe the development of supportive media related to the skills to be developed. Activities will be aligned with the learning outcomes in a structured manner so that each activity describes the competencies it addresses.

The implementation of a competency-based curriculum requires a simultaneous change in program, instruction and assessment practices. There is a need to develop project and problem-based learning as instruction tools and use different types of learning activities, for example, class tutorials, individual practical activities, and group activities. Lab work is used to supplement class learning by students working on relating theory to working circuits. Project-based learning is used in order to provide an authentic engineering environment and promote 'real world' skills intended to simulate professional situations. Authentic assessment is therefore a major component of the project as is problem-based learning. The project production process will also develop students' content knowledge and acquired skills. Staff should work together in teams as tutors, lab assistant, and resources provider to provide and assess all student-learning activities.

Category - Employability (Generic) Skills

Key competencies exist and play a significant role in our ability to manage our lives, and in the workplace these key competencies are also referred to as employability skills or generic skills. Such skills can only be of use if the person is deemed to have attained competence in these skills. A definition of competence includes these elements: "it embodies the ability to transfer and apply skills and knowledge to new situations and environments. This is a broad concept of competency in that all aspects of work performance, not only narrow task skills, are included." National Training Board - (Australian Education Council. Mayer Committee, 1992a, p.7, citing the National Training Board, 1991).

It has been shown that there a link between the development of the key competencies and the use of education practices such as adult learning principles, advanced teaching/training technologies, holistic approaches to learning, problem based learning and learner-centred approaches. In these learning environments, students develop lifelong learning skills, they learn reflection, evaluation and articulation on learning experiences, and learn the 'how', 'why' and exploring of 'what if' situations … not just learning the facts.

A summary of key competencies include the collecting, analysing and organising of information, communicating ideas and information, planning and organising activities, working with others and in teams, using mathematical ideas and techniques, solving problems and using technology.

Category - Desirability of Employability Skills

Publications in New Zealand have identified the need for the development of a skills based workforce, (Skill New Zealand, 2001, 2002), but these publications do not identify the actual skills required. The results from the skills survey has now provided that list of skills and the summary as listed below lists the desirability of skills in ranked order from most desirable to least desirable.

Table 4.13

Ranked Order of Employability Skills in Order of Most Desirable Skills First.

Ranked Order	**Employability Skill**
1	Motivation
2	Enthusiasm
3	Initiative
4	Numeracy
5	Problem solving skills
6	Literacy
7	Logical and orderly thinking
8	Team work
9	Ability to benefit from on-the-job training
10	Flexibility and adaptability
11	Customer/client/patient focus and orientation
12	Inter-personal skills with other staff
13	Capacity for independent and critical thinking
14	Time management skills
15	Capacity to handle pressure
16	Maturity
17	Basic computer skills
18	Oral business communication skills
19	Personal presentation and grooming
20	Academic learning
21	Written business communication skills
22	Creativity and flair
23	Project management skills
24	Comprehension of business practice
25	Leadership qualities

Category - National Certificate of Educational Achievement (NCEA)

Students are now coming into the tertiary education system from schools with an assessment experience based on the NCEA. As this is different to the traditional school examination system, it is deemed important and necessary in the context of this study to include a category with some of the key points about this assessment system. The question here is, do we as tertiary teachers know or understand anything about NCEA assessment using achievement standards and the associated learning, and therefore the background of students entering tertiary education?

Extracts are taken from QA news June 2001, issue 38, a special issue of QA news devoted to the National Certificate of Educational Achievement (NCEA), accessed at http://www.nzqa.govt.nz/publications/newsletters/qanews/june-2001/story1.html#fao

There is a difference between achievement standards and unit standards. Achievement standards are similar to unit standards in that they provide criteria for assessing student performance. In general they don't prescribe content or the full texture of a curriculum (that is done in curriculum statements) and they don't prescribe exactly how assessments are to be carried out. Like an exam-marking schedule, standards describe the levels of achievement students need to attain in the various aspects of a subject in order to gain the various credits that are attached to those aspects.

Achievement standards differ from unit standards in a number of ways. The first two are obvious and definitive. For each achievement standard there is a broad explanation of how students are to be assessed: by examination (or other external assessment) or internally. Within those constraints, like unit standards, examiners and schools can decide exactly what assessment tasks and activities are appropriate. Each achievement standard describes the standard required to achieve whatever credits are available (just like a unit standard) and two further standards for the award of merit and excellence grades.

Achievement standards differ from unit standards in two less obvious and definitive ways. Achievement standards are derived from national curriculum statements for secondary schools. Unit standards were developed for school subjects on the basis of curriculum statements as well as the expectations of tertiary providers and the relevant industry. Achievement standards tend to be 'broader' and 'leaner' than unit standards. NCEA policy suggests between five and eight achievement standards in each subject and achievement standards tend to have fewer specific performance criteria.

Category - Tertiary Education Advisory Commission (TEAC)

The Tertiary Education Advisory Commission (TEAC) has a relationship with the Ministry of Education in that it will provide "independent advice to the Associate Minister of Education (Tertiary Education) on the broad policy principles that should underpin particular areas of Government tertiary education policy" (Tertiary Education Advisory Commission, 2000, p. 35). In the initial report, TEAC reached 12 initial conclusions with conclusions 3, 4 and 5 being of interest in this study. Conclusion 3 states, "The needs of learners should be recognised as central to the design of the tertiary education system" (p. 10). This defines the purpose of tertiary education, which "has a number of separate, yet inter-related and overlapping purposes. These include: Inspiring and enabling individuals to develop their capabilities to the highest potential levels throughout life, so that they develop intellectually, are well-equipped to participate in the labour market, can contribute effectively to society and achieve personal fulfilment..." (p. 10). Thus conclusion 3 looks at the needs of learners and includes the obligation for tertiary education to consider their intellectual, social and personal needs. Conclusion 4 considers the different functions of tertiary education in meeting these intellectual, social and personal needs by concluding, "The importance of the multiple functions of the tertiary education system should be recognised" (p. 11). In order to achieve this recognition of importance, steps that will need to be considered are firstly, "establishing a commitment to equipping people from their initial encounter with tertiary education with the knowledge, skills and understanding to continually secure further knowledge and skills throughout their lives”. Secondly, “establishing robust systems of learning and credit recognition and transfer that will enable people to have their current learning continually evaluated and recognised in terms of its continuing relevance and contribution to meeting changing needs”. Thirdly, “exploring the mechanisms required to assist individuals and organisations to acquire the necessary entitlement to upgrade their knowledge to meet new business and social needs” (p. 11). Having considered the purpose of tertiary education, conclusion 5 concludes that “the tertiary education system needs to be designed to respond to the challenge of lifelong learning in a knowledge society, and this may require new ways of organising, delivering and recognising tertiary education and learning” (p. 12). While a commission to report to the Minister has reached these conclusions, they are fundamental principles that should be seen to be reflected throughout the whole of the tertiary education system through institution policies with support and encouragement into the classroom.

Summary of General Learning Sub-group

The following categories were discussed in this sub-group…

Table 4.14

Categories Associated with the General Learning Sub-group

Collaborative Learning	General Learning Sub-group
Competency-Based Education	
Designing a Competency-Based Curriculum	
Employability (Generic) Skills	
Desirability of Employability Skills	
NCEA Student Experience	
Tertiary Education Advisory Commission (TEAC)	

4.6.6 Adult Learning Sub-group

Category - Adult Learning Environment

Learning environments that foster adult student constructivist learning will prepare them for the workplace by helping them develop connections between subject content and the context of application. This type of learning environment will help students expand the ability of the thinking brain to solve problems and demonstrate the correlation between learning to think and learning to work.

Students who are presented with such a learning environment where they search for meaning, appreciate uncertainty, and inquire responsibly, will provide opportunities for them to make connections with their own life experiences. Through this process, each student's understanding of their thought processes and self-evaluative skills will be developed so they can assess what they need to learn in order to solve a problem or complete a project. Practices can be implemented that encourage students to think and rethink, demonstrate and exhibit, assimilate and demonstrate knowledge in a way that can be useful in new situations. It will help students develop the capabilities of their brain to make the connections between knowledge and the application of knowledge and avoid situations where students only develop an ability to memorize facts in a textbook.

Adult student constructivist learning environments will encourage student-to-student interaction, initiate lessons that foster cooperative learning, and provide opportunities for students to be exposed to interdisciplinary curriculum. It will lead students to engage in higher-order thinking and provide opportunities for students to process information through various avenues of expression (written, oral, building, drawing, etc). Programs can be supplemented with transitional components such as academic skills, productive work habits, work values, career decision-making skills, and metacognitive and self-evaluative skills so they can assess what they need to learn in order to solve a problem or complete a project.

Students can be encouraged to direct their own learning, to recognize what skills they need, to learn their skills on their own and involve themselves in lifelong learning. This approach to learning will continually prepare them for new employment and career opportunities and offer students an expanded focus for vocational education, one that extends beyond the limits of job training. Opportunities should be presented to initiate connected and constructivist ways for students to think and learn as important aspects of career development, career interests, choice, planning, and performance. Students can be invited to search for understanding, appreciate uncertainty, and inquire responsibly, while accepting the uncertainty that accompanies them as they pursue areas that are new to them.

Finally, adult student constructivist learning environments requires educators who are willing to take risks, to forego the need for ‘control’ and to allow students to pursue their own learning, to ask their own questions and seek their own answers.

Category - Good Practice in Undergraduate Education

Good practice in undergraduate education should communicate high expectations to the students. There is a need to respect the diverse talents and ways of learning among adult students and it is important to bring together their varied experiences and integrate these experiences with student learning. Active learning and cooperation among students should be encouraged. Prompt feedback is important and it is necessary to emphasize time on task. Student-faculty contact outside of class should be encouraged.

Table 4.15

Twelve Attributes of Quality in Undergraduate Education

Twelve attributes of quality in undergraduate education:

- The organizational culture must have…
  - (1) high expectations,
  - (2) respect for diverse talents and learning styles, and
  - (3) an emphasis on the early years of study.
- A quality curriculum requires…
  - (4) coherence in learning,
  - (5) synthesis of experiences,
  - (6) ongoing practice of learned skills, and
  - (7) integration of education and experience.
- Quality instruction incorporates…
  - (8) active learning,
  - (9) assessment and prompt feedback,
  - (10) collaboration,
  - (11) adequate time on task, and
  - (12) out-of-class contact with faculty.

Category - Student-Centred Learning

Student-centred learning requires students to take an active role so that their learning will occur deeply, endure, be enjoyable, and transfer to contexts beyond the classroom. Instruction from a learner-centred perspective will facilitate student construction of knowledge, and as they construct their own learning, they will build on the beliefs, knowledge and understanding they bring with them. Successful learner-centred learning can achieve many positive advantages for teachers and students.

Learner-centred instruction embedded in constructivism principles requires teachers who respect diverse talents and ways of learning among their students, and who provide prompt, constructive feedback on student performance. There needs to be frequent student-faculty interaction to keep students focused on their learning, not on other distractions.

Cooperative learning activities should be interspersed among other engaging instructional formats and authentic assessment tasks should be used as well as traditional assessment tasks. Learning activities that attract students' interest are important so that students are actively involved in their learning. Students will become autonomous learners as they become aware of the process of learning itself.

Communication of clear learning objectives to students is important, as is the use of graphical learning aids to help students understand relationships between concepts. Students should recognise that the material to be learned is important so they can relate new material to information they already know and act on the information at a deep level. There is a continual need for students to check and update their understandings based on new experiences and transfer new learning automatically to new contexts to which it is relevant.

Category - Summary of Adult Learning Sub-group

The following categories were discussed in this sub-group…

Table 4.16

Categories Associated with the Adult Learning Sub-group

Adult Learning Environment	Adult Learning Sub-group
Good Practice in Undergraduate Education	
Student-Centred Learning	

4.6.7 Classroom/ Laboratory Environment Sub-group

Category - Computer Simulated Laboratory Learning

An appraisal of the literature relating to computer-simulated laboratory learning revealed that the computer simulation of laboratory tasks could be used to replace a traditional laboratory in an electrical engineering course. The use of computer simulation provides lower cost and easy-to-schedule lab time critical to enable learners to develop knowledge and skill. The provision of simulated labs with equivalent learning performance is an alternative to physical labs for those courses that require application of theory. This approach provides students in technical professions with a flexible schedule with highly productive learning time because simulation can be used at any time and any place to facilitate life-long learning.

Computer-simulation can be integrated with curriculum and instruction to become a powerful learning tool. It will support collaborative learning and facilitates learning and the learning strategies that it enables. It can be used to bring real-world examples into the classroom and provide opportunities for authentic assessment by providing learning simulations that typically require job-like performance. Active learning is inherent in the methodology and will reveal the concepts being examined more clearly. This can result in improved student understanding for the type of experiment where the traditional laboratory does not make concepts physically available to our senses.

Simulation can be used for developing technical and interpersonal skills, and stimulate the development of higher order thinking and problem-solving skills. The conceptual understanding of complex, naturally occurring situations and events will be enhanced by integrating technology and subject matter. Challenging evaluative simulations that integrate assessment, learning and performance support can provide opportunities for exploration and learning beyond the minimum level of learning.

Category - Electronics/Electrical Laboratory Learning Environment

The basis for change in the laboratory-learning environment for this study was in turn based on research by the author some years before. This research resulted in positive support from students to work in a self-paced environment rather than the ‘one set laboratory exercise per period’ regime. Management at that time was unsupportive of innovative changes in the established teaching environment so the change was short lived. During the two year period that preceded this study, a change in management and the need for changes produced the opportunity to reintroduce the self-paced approach to laboratory lessons with some modifications as part of a possible answer to allowing a more student orientated learning environment and one that would support the primary focus of this study which was to find a way to resolve the simultaneous, dual assessment difficulty.

During this time, further trial and error, action research based changes in the teaching/learning environment were modelled in an attempt to support the implementation of a successful assessment framework. A study was conducted of that laboratory-learning environment to determine student satisfaction using an Electronics Laboratory Environment Inventory (ELEI) questionnaire. The following is part of the documentation associated with that study and is presented as researcher known data that impacts into the theoretical model of a teaching/learning environment under study in this report.

This evaluation instrument was adapted from the Science Laboratory Environment Inventory discussed in (Fraser, Giddings, & McRobbie, 1992). Modifications were limited to removing the word “Science” from the items. Since nearly all students were also doing the Direct Current Circuits course and that laboratory environment is very similar to the Digital Electronics course, it was decided not to impose two ELEI evaluations on these students.

The graph revealed that there was only minor variation between the student’s actual rating of the environment and their preferred environment.

Results from the research study are given below.

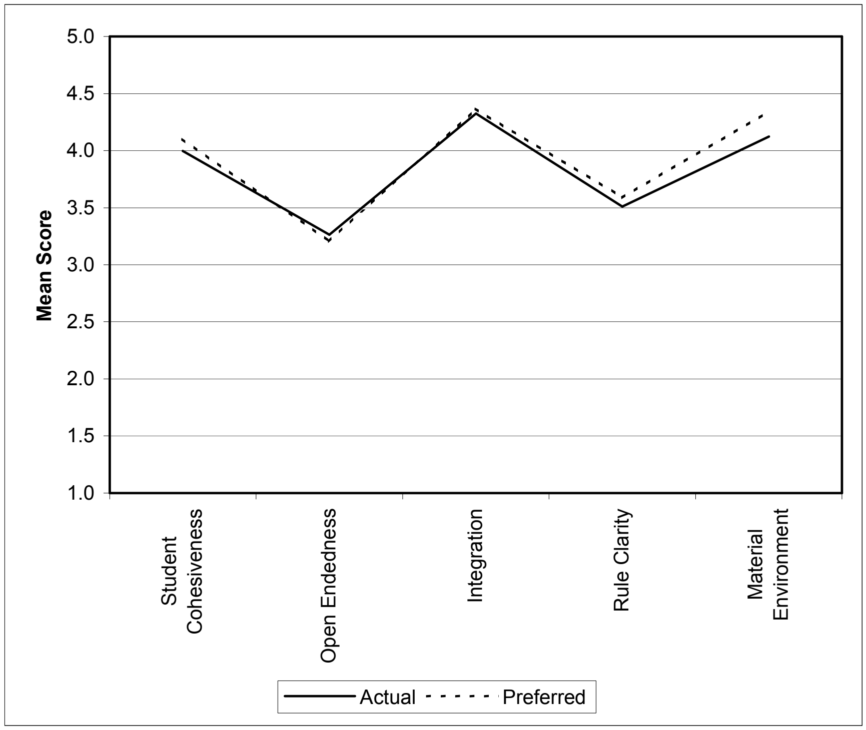

Figure 4.5. ELEI learning environment evaluations

These data become an input into the teaching/learning environment in that the approach to laboratory sessions was substantially one in which students were satisfied with and an environment that forms a basis for the theoretical model. The area of material environment was primarily one outside the control of the teacher and was in itself remedied the following year with a repaint of the interior of the laboratory, new workbenches and an alternative friendlier workspace layout. Untested feedback from students indicated satisfaction with the physical environment.

The environment tested under this study can be summarised as one that allows students…

- To work in pairs to promote the opportunity for development of other skills such as working in small groups and collaborative learning.
- Opportunity to set their own time frame, to work at their own pace within their time frame and develop time management skills.
- The flexibility to catch up because of missed periods or to extend an exercise into the following week if there had been an equipment failure.
- The flexibility to use computer simulation for set exercises either during programmed laboratory sessions or at their convenience in a ‘drop in’ computer suite.
- The opportunity to prepare for a laboratory exercise by doing circuit diagrams, calculations, etc. during ‘out of class’ time before attending the programmed laboratory session to attempt the actual exercise.
- The flexibility to use the laboratory at other than their programmed session (given that laboratory use, security of the laboratory and electrical safety issues needed to be considered).

Category - Performance-Based Instruction

Seven principles of performance-based instruction.

- Establish clear student outcomes, so that the curriculum is the focus in terms of desired performances of understanding. Relate the performance targets to the curriculum, instruction, and assessment so that performance assessments become targets for instruction and learning. In this manner, students can demonstrate their understanding of their learning goals and objectives through performance assessment.
- Strive for authentic assessment so that as students are involved in authentic work related tasks, their performance will require them to demonstrate their knowledge and skills in a manner that reflects the real world.
- Communicate assessment criteria and performance standards because authentic performance tasks rarely have a single, correct answer, and

evaluation of student products and performances should be based upon judgment and guided by clear criteria. The criteria are best incorporated into a clear and well-defined scoring tool (e.g., rubrics, rating scales, or performance lists).

- Provide examples of proficiency to students that illustrate excellence in performance so that they know what excellent work looks like. Models of quality work can also assist the instructor in performance-based instruction in the classroom.
- Teach strategies explicitly to assist students improve their performance on academic tasks. Use techniques such as purpose of the strategy, demonstration of use, practice by students under the guidance of the instructor so that students can then independently and/or in teams, regularly reflect on the appropriate uses of the strategy and its effectiveness.
- Use on-going performance assessment for feedback and improvement. On-going quality formative assessment to provide feedback for improvement is very important. Practice, an adjustment based on feedback, and more practice develops deep understanding and proficiency.
- Document and recognize progress because regular and quality feedback assists in developing students' sense of achievement. Portfolios or other collections of student work are a way of documenting progress.

Category - Skills – Outcomes

Engineering Technicians must be competent throughout their working life, by virtue of their education, training and experience, to:

A Use engineering knowledge and understanding to apply technical and practical skills, review and select appropriate techniques, procedures and methods to undertake tasks, and use appropriate scientific, technical or engineering principles.

B Contribute to the design, development, manufacture, construction, commissioning, operation or maintenance of products, equipment, processes, systems or services, identify problems and apply diagnostic methods to identify causes and achieve satisfactory solutions, and identify, organise and use resources effectively to complete tasks, with consideration for cost, quality, safety and environmental impact.

C Accept and exercise personal responsibility, work reliably and effectively without close supervision to the appropriate codes of practice, accept responsibility for work of self and others, and accept, allocate and supervise technical and other tasks.

D Use effective communication and interpersonal skills, use oral, written and electronic methods for the communication in English of technical and other information, work effectively with colleagues, clients, suppliers and the public.

E Make a personal commitment to an appropriate code of professional conduct, recognising obligations to society, the profession and the environment. Comply with the Codes and Rules of Conduct of their Licensed Institution or Professional Affiliate. Manage and apply safe systems of work, undertake their engineering work making and utilising risk assessments, and observing good practice with regard to the environment, carry out continuing professional development, including opportunities for this offered by their Institution, to ensure competence in areas and at the level of future intended practice.

A good academic curriculum can lead to these employability skills being taught in the context of a rich academic experience and prevent the competition for time between employability skills and academic courses. While it is possible to provide students with specific courses to develop skills (e.g., communication skills, computer skills, etc), experience also suggest that students derive the greatest benefit when they are engaged in academic-related group work supported by suitable tutors. As part of this type of learning environment, the assessment of student learning has a much wider impact that just marking examinations or papers of students.

Summary of Classroom Learning Sub-group

The following categories were discussed in this sub-group…

Table 4.17

Categories Associated with the Classroom Learning Sub-group

Computer Simulated Laboratory Learning	Classroom Learning Sub-group
Electronics/Electrical Laboratory Learning Environment	
Performance-Based Instruction	
Skills – Outcomes	

4.6.8 Development of the Theoretical Model

Once the categories had reached theoretical saturation and the data clarified and simplified, the process of building the principal categories from the sub-categories began. The first step was to identify the type of primary source from which each category evolved and this is shown in table 4.18. The next step in systematically relating the categories was to group and sort them according to the two main groups of a teaching/learning environment and the assessment framework. This is shown in table 4.19.

Table 4.18

List of Grounded Theory Categories Included in the Theoretical Model and their Primary Source

Title of Category	**Authoritative Document**	**Related and Condensed Documents**	**Survey Report**
Achievement-Based Assessment: NZQA	✓		
Adult Learning Environment		✓	
Assessment for Learning	✓		
Assessment for Skills Development		✓	
Assessment for the NQF: NZQA	✓		
Assessment of Unit Standards: NZQA	✓		
Assessment Principles		✓	
Assessment Towards In-Depth and Student-Centred Learning		✓	
Authentic Assessment Principles		✓	
Collaborative Learning		✓	
Competency-Based Education		✓	
Computer Simulated Laboratory Learning		✓	
Creating Meaningful Performance Assessments		✓	
Designing a Competency-Based Curriculum		✓	
Diploma in Technology Curriculum Document	✓		
Electronics/Electrical Laboratory Learning Environment			✓
ElectroTechnology Industry Training Organisation	✓		
Employability (Generic) Skills		✓	
Employability Skills Survey			✓
Fair Assessment		✓	
Good Practice Assessment Principles		✓	
Good Practice in Undergraduate Education		✓	
Learning Goals and Outcomes		✓	
MYTEC Academic Regulations	✓		
MYTEC Assessment Policy	✓		
NCEA	✓		
Performance-Based Instruction		✓	
Planning and Developing Assessment		✓	
Principles of Standards-Based Assessment	✓		
Scoring Rubrics		✓	
Skills – Outcomes		✓	
Student-Centred Learning		✓	
Tertiary Education Advisory Commission (TEAC)	✓		
Validity Promoting Assessment Procedures	✓		

Table 4.19

List of Grounded Theory Categories Included in the Theoretical Model and their Primary Group

Title of Category	**Assessment Framework**	**Learning Environment**
Achievement-Based Assessment: NZQA	✓	
Assessment for Learning	✓	
Assessment for Skills Development	✓	
Assessment for the NQF: NZQA	✓	
Assessment of Unit Standards: NZQA	✓	
Assessment Principles	✓	
Assessment Towards In-Depth and Student-Centred Learning	✓	
Authentic Assessment Principles	✓	
Creating Meaningful Performance Assessments	✓	
Diploma in Technology Curriculum Document	✓	
ElectroTechnology Industry Training Organisation	✓	
Fair Assessment	✓	
Good Practice Assessment Principles	✓	
Learning Goals and Outcomes	✓	
MYTEC Academic Regulations	✓	
MYTEC Assessment Policy	✓	
Planning and Developing Assessment	✓	
Principles of Standards-Based Assessment	✓	
Scoring Rubrics	✓	
Validity Promoting Assessment Procedures	✓	
Adult Learning Environment		✓
Collaborative Learning		✓
Competency-Based Education		✓
Computer Simulated Laboratory Learning		✓
Designing a Competency-Based Curriculum		✓
Electronics/Electrical Laboratory Learning Environment		✓
Employability (Generic) Skills		✓
Employability Skills Survey		✓
Good Practice in Undergraduate Education		✓
NCEA		✓
Performance-Based Instruction		✓
Skills – Outcomes		✓
Student-Centred Learning		✓
Tertiary Education Advisory Commission (TEAC)		✓

Assessment Framework Data Group

The categories for the assessment framework were then related and sorted into three sub-groups; general assessment, achievement-based assessment, and competency-based assessment.

Table 4.20

List of Assessment Framework Categories and their Sub-Group

Title of Category	General Assessment	Achievement-Based Assessment	Competency-Based Assessment
Assessment for Learning	✓		
Assessment for Skills Development	✓		
Assessment Principles	✓		
Assessment Towards In-Depth and Student-Centred Learning	✓		
Authentic Assessment Principles	✓		
Creating Meaningful Performance Assessments	✓		
Fair Assessment	✓		
Good Practice Assessment Principles	✓		
Learning Goals and Outcomes	✓		
MYTEC Academic Regulations	✓		
MYTEC Assessment Policy	✓		
Planning and Developing Assessment	✓		
Scoring Rubrics	✓		
Validity Promoting Assessment Procedures	✓		
Achievement-Based Assessment: NZQA		✓	
Diploma in Technology Curriculum Document		✓	
Assessment for the NQF: NZQA			✓
Assessment of Unit Standards: NZQA			✓
ElectroTechnology Industry Training Organisation			✓
Principles of Standards-Based Assessment			✓

Assessment Framework Concept Map

A concept map produced from this analysis reveals the systematic relationships and linkages between categories that are well defined and grounded in the data.

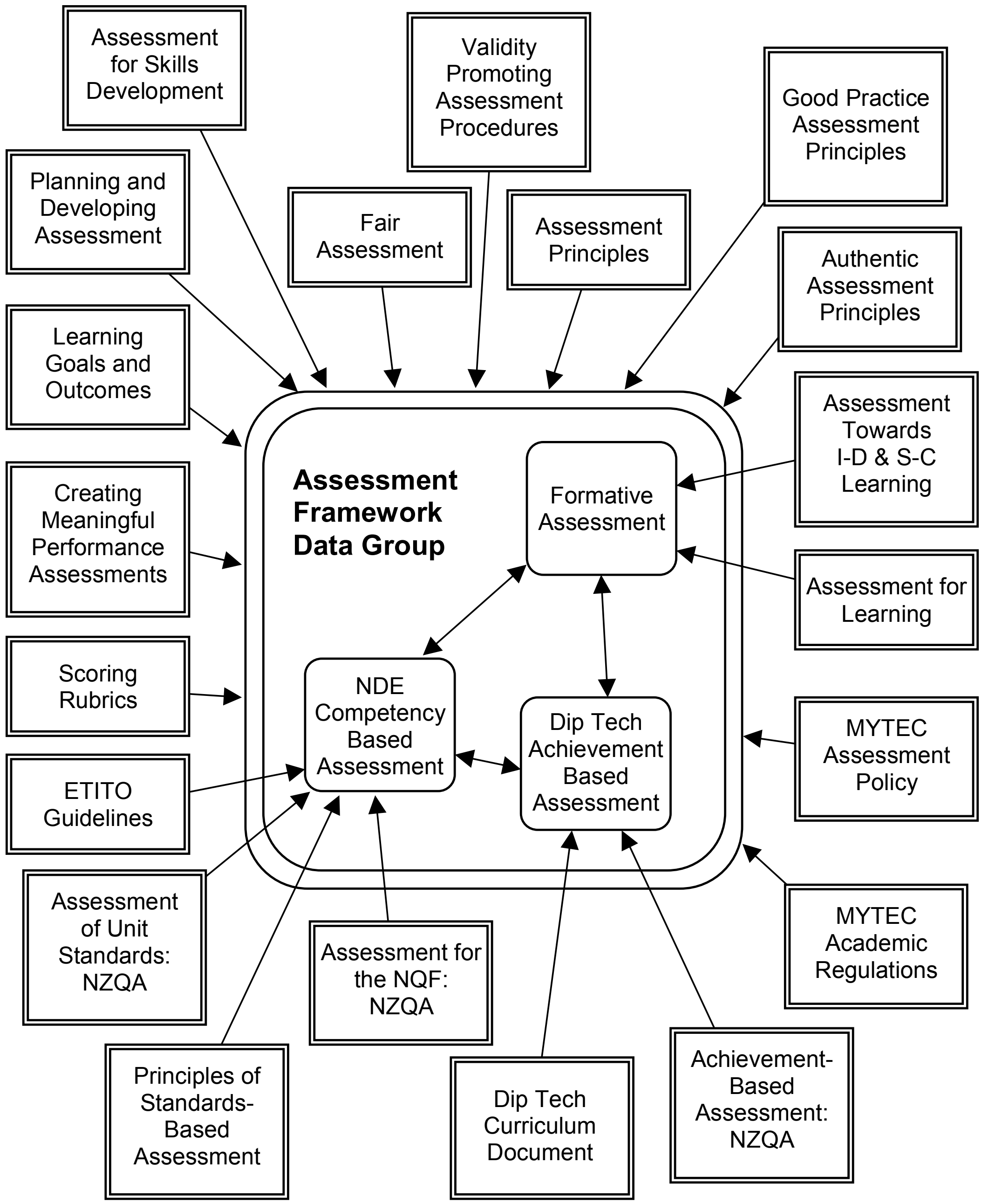

Figure 4.6. Assessment Framework Data Group concept map

Categories that are linked to the overall core category with arrows to the outside box are deemed to be relevant to the overall assessment framework data group, while those categories that are linked with arrows to an internal category are deemed to be relevant that part of the assessment framework.

Learning Environment Data Group

The categories for the learning environment group were then sorted into three sub-groups, principles of adult learning, classroom/laboratory environment, and general learning considerations.

Table 4.21

List of Learning Environment Categories and their Sub-Group

Title of Category	General Learning Considerations	Principles of Adult Learning	Classroom/ Laboratory Environment
Collaborative Learning	✓		
Competency-Based Education	✓		
Designing a Competency-Based Curriculum	✓		
Employability (Generic) Skills	✓		
Employability Skills Survey	✓		
NCEA Student Experience	✓		
Tertiary Education Advisory Commission (TEAC)	✓		
Adult Learning Environment		✓	
Good Practice in Undergraduate Education		✓	
Student-Centred Learning		✓	
Computer Simulated Laboratory Learning			✓
Electronics/Electrical Laboratory Learning Environment			✓
Performance-Based Instruction			✓
Skills – Outcomes			✓

Learning Environment Concept Map

A concept map produced for the learning environment also reveals the systematic relationships and linkages between categories that are well defined and grounded in the data.

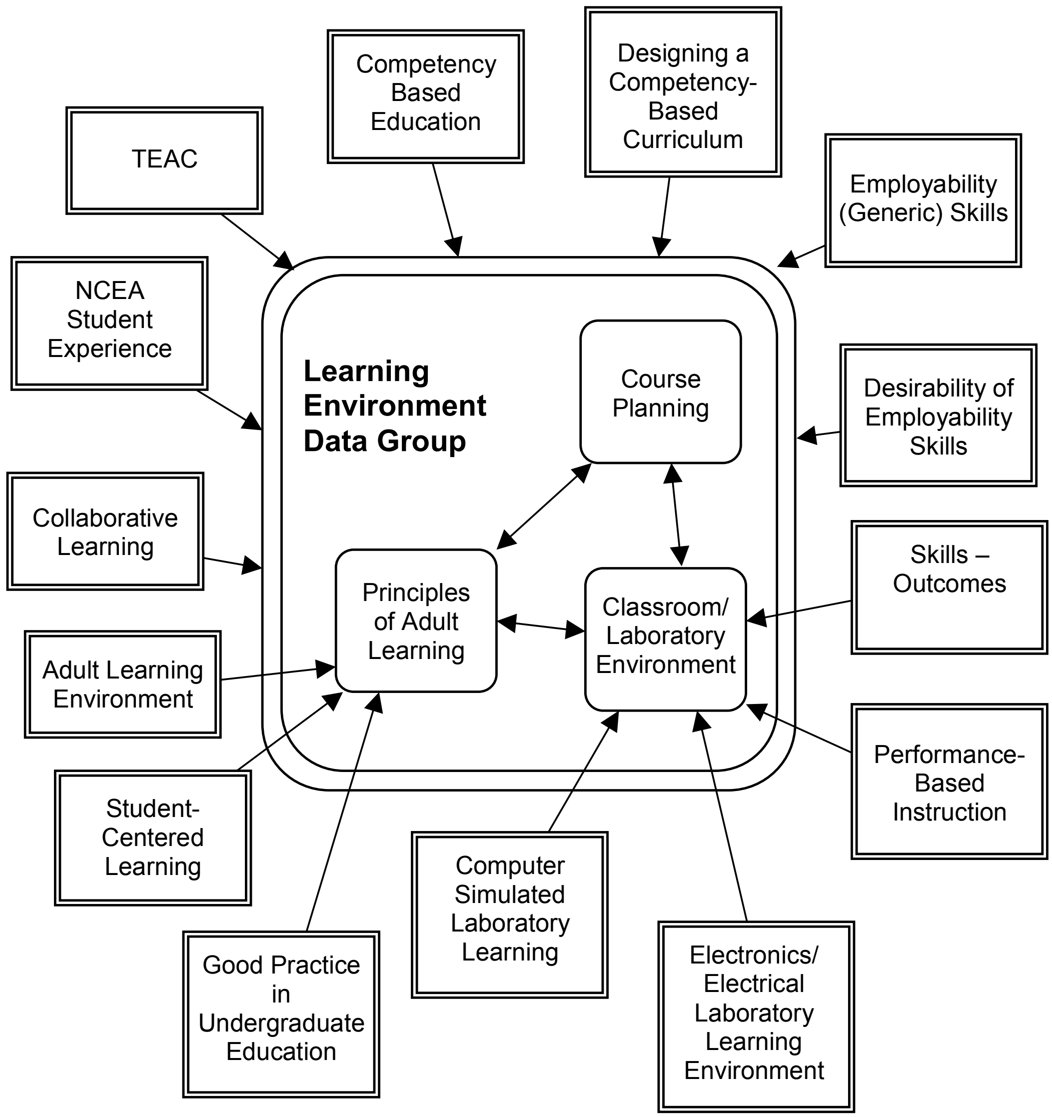

Figure 4.7. Learning Environment Data Group concept map

Similarly, categories that are linked to the overall core category with arrows to the outside box are deemed top be relevant to the overall environment, while those categories that are linked with arrows to an internal core category are deemed to be relevant to that core category.

Teacher's 'Housekeeping' Concept Map

The third group of 'data' that inputs into the whole of the teacher's responsibilities are a group of requirements that indirectly comes from many sources. Essentially these are the 'behind the scenes' requirements such as course design, lesson plans, production of assessments, preparation of teaching notes, preparation of handouts, preparation of laboratory exercises, and record keeping.

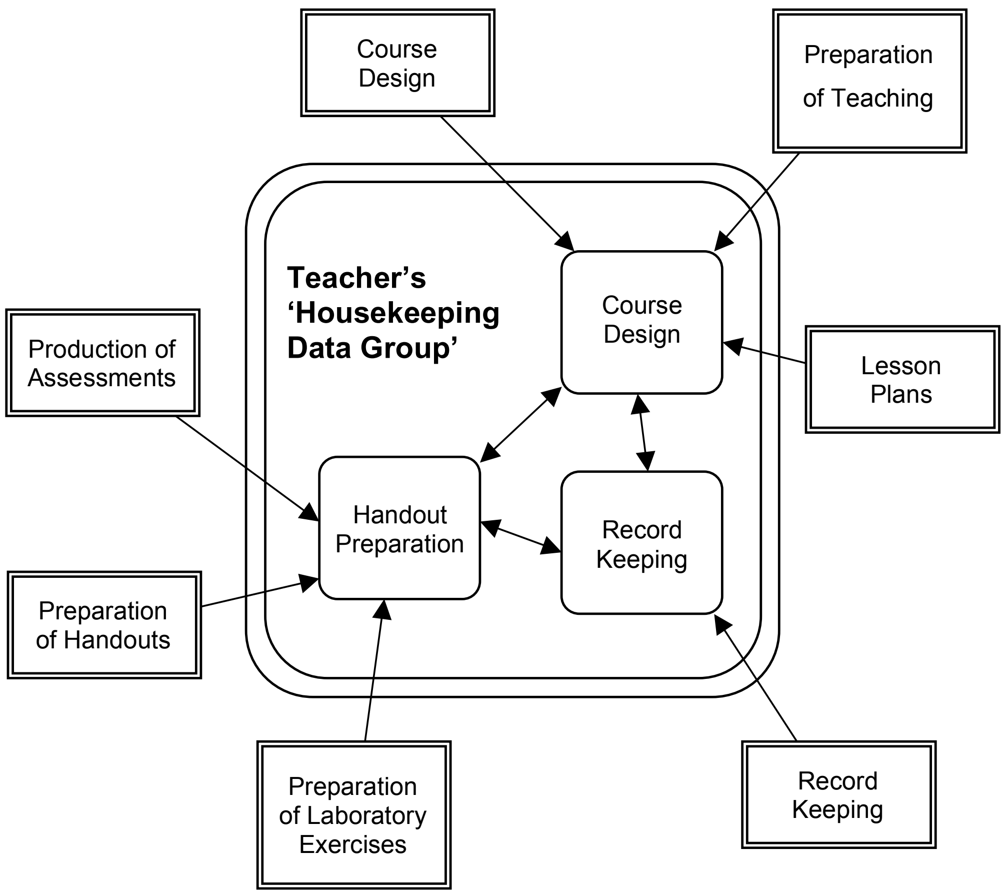

Figure 4.8. Learning Environment Data Group concept map

Although the majority of ‘data’ that control or direct this work is intuitive and based on experience rather than documented requirements, there are many indirect inputs from other categories that have not been specifically identified as well as inputs from those categories which have been identified and discussed.

Teacher’s Responsibilities Concept Map

The responsibilities of the teacher can then be formulated by considering their role in sorting out the ‘black box’.

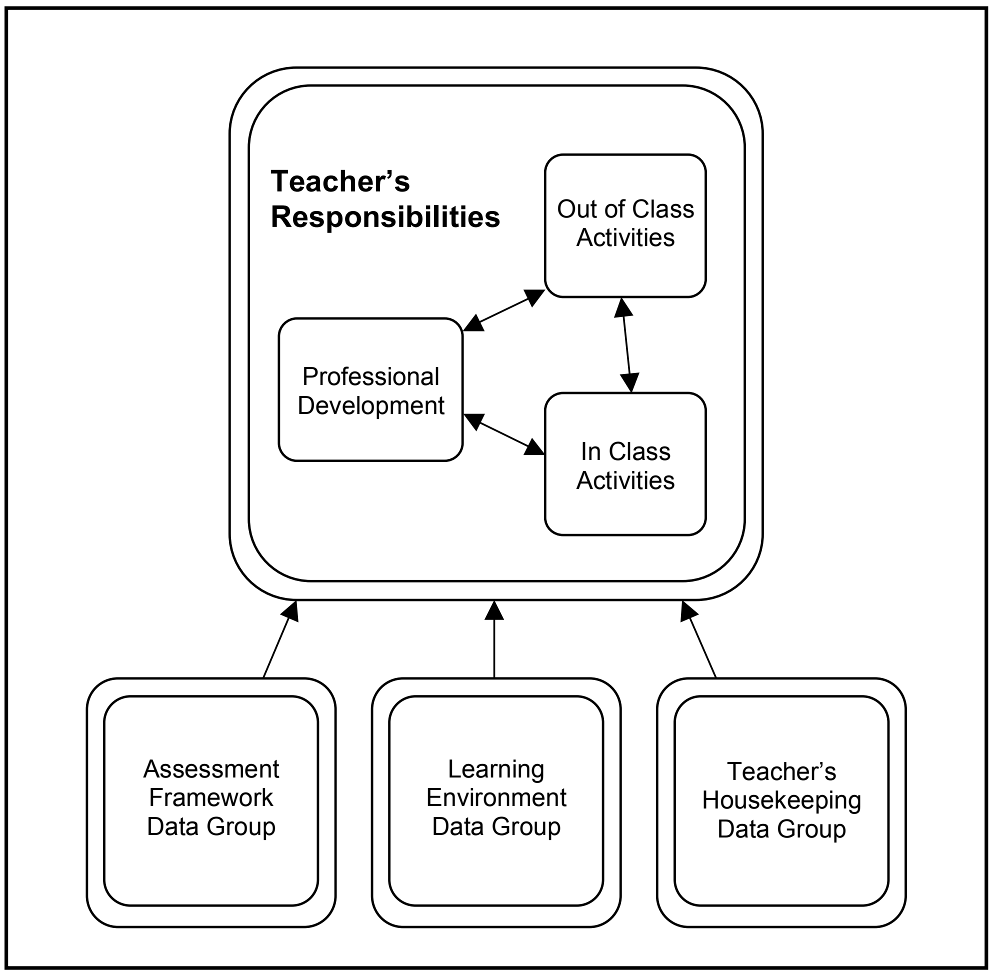

Figure 4.9. Teacher’s Responsibilities concept map

All of the concepts considered in the assessment framework data group, the learning environment data group and the 'housekeeping data group' are then considered to be linked into this core category of teacher's responsibilities.

4.7 SIGNIFICANCE OF THEORETICAL FINDINGS

The theory defined from this process and data gathering, analysing and linking is the resulting model from the data that I as the teacher/researcher have obtained. What started as an open and generalised research focus to uncover data that would help in understanding the teaching/learning environment, has been the emergence of a theoretical model that accounts for the research situation as it is and one that is grounded in theory. It is acknowledged that another teacher/researcher in a different teaching environment with a different focus would produce a different set of categories and/or with variations in the content.

Within the model, the categories or the data, no one significant factor was found that in itself would present an answer to the assessment difficulty. Rather, by understanding the big picture in depth, there was both a better understanding of the different concepts and a support for direction that evolved into a working model based on experiential intuition. The supportive nature of the data came from two sources that I describe as the authoritative data and the helpful data. Authoritative data such as policies and curriculum documentation were somewhat frustrating in their restrictiveness, yet other authoritative data were supportive by virtue that it clearly defined and gave grounding of positive arguments for innovation; for example, TEAC's statements of "The needs of learners should be recognised as central to the design of the tertiary education system" and "The tertiary system needs to be designed to respond to the challenge of lifelong learning in a knowledge society, and this may require new ways of organising, delivering and recognising tertiary education and learning". Other 'authoritative' data such as the employability skills survey supported the argument that the development of skills other than academic learning should be an integral part of the learning environment. Helpful data came primarily from those articles written by teaching practitioners or those who are closely working with and for teachers. By sharing their experiences, they in turn contribute to the professional development of others, a key point in case study and action research methodology.

4.8 SUMMARY

The grounded theory research has created a model that contains many categories and data, some of which are generic to tertiary education, some are specific to New Zealand, some specific to engineering education and some specifically to the institution that I worked in. It is quite probable that other researchers in the same position may have developed a different model, yet the same underlying concept would probably thread its way through every model, that of conflict of interests. The main focus in this study was to dig deeply into the available literature and to take time to develop a greater understanding of the complexity of the ‘black box’ of the teacher. Many things have been found, yet many things remain unanswered. Probably, the biggest question is still the teacher asking, “How do I achieve this dual assessment”?

CHAPTER 5

PHASE TWO – PRACTICAL MODEL

5.1 INTRODUCTION

Performance assessment may be defined as a method of assessment that requires students to create an answer or perform an exercise that demonstrates their knowledge and skills such as doing mathematical calculations, conducting experiments, writing extended essays, etc. Performance assessments should measure important learning outcomes, motivate high performance and require the demonstration of complex understanding and thinking applicable to important problem areas. Fair assessment practices can be promoted by having clearly stated learning outcomes that match the assessment to what is taught (i.e. the curriculum). The use of many different measures and many different kinds of measures can also promote fairness, as does helping students learn how to do the assessment task by providing clear instructions and good examples.

The planning and development of assessment should start with the development of the framework for the assessment. This framework serves as the guide to the entire assessment and consists primarily of the course and lesson objectives set out to ensure that each is assessed. As part of this process, the development of performance assessments includes identifying goals and course outcomes, identifying specific learning outcomes for each broad goal and the development of performance criteria for each learning outcome. The statement of goals and the accompanying learning outcomes are essential to provide a clear focus for both instruction and assessment.

Once the assessment framework has been developed, the assessment plan is developed from the framework and is used to provide an overview of the types of assessment to be developed and used. In addition it will describe the types of assessments that are to be used and how assessments will be administered, scored, and reported. The process of developing the assessment plan should include the identification of the educational goals, learning outcomes and performance criteria in order to define exactly what is expected of students. This will lead to identification of a valid set of assessment instruments in order to achieve multiple measures of student achievement of the goals, and the identification of the feedback path so that the resulting performance information can be used to improve teaching and student performance. The assessment design will then describe the characteristics of an adequate assessment for each content area of the assessment framework and should guide the development of the assessment instruments for each outcome that are needed in keeping with the available resources. Assessment design should include means for feedback to the student and evaluation of whether the performance criteria were met and the outcomes achieved. Marking schedules and/or criteria used to assess student responses should be identified and these include samples of how the students could respond and how such responses will be recorded and scored.

As this chapter is aimed at the 'how' of sorting out the assessment difficulties, the process I used in this study followed the four steps, "development of the assessment framework, creation of the assessment plan, determination of assessment resources, and production of the assessment blueprint" (Roeber, 1996), with three extra steps added, development of a marking system, production of assessment instruments and establishment of the learning environment.

The resulting order in which the steps were taken, were…

1. Development of the assessment framework.
2. Creation of the assessment plan.
3. Determination of assessment resources.
4. Development of a marking system.
5. Production of the assessment blueprint.
6. Production of assessment instruments.
7. Establishment of the Learning Environment.

The central pursuit of this chapter is to document the processes whereby the reference to the simultaneous dual assessment of “it can’t be done”, was moved towards “there has to be a way”. Paralleling the pursuit of focussing on the assessment requirement was the inherent need to ‘take on board’ many of the important principles outlined in the theoretical model categories.

Section 5.2 outlines the processes of the development of the assessment framework which primarily involves the consideration of the underlying assessment conditions presented in this scenario and the rationalisation of learning outcomes and objectives. Section 5.3 discusses the creation of the assessment plan, while Section 5.4 summarises a determination of assessment resources. An outline of the development of a marking system is provided in Section 5.5 and Section 5.6 discusses the production of the assessment blueprint. Section 5.7 provides an insight into the production of assessment instruments and Section 5.8 discusses some of the conditions of the establishment of the learning environment.

5.2 DEVELOPMENT OF THE ASSESSMENT FRAMEWORK

5.2.1 Introduction

There are many important considerations involved in establishing an assessment and evaluation framework (Fraser, 1996). Some of these considerations include matching the emphasis on summative evaluation with an equal or greater emphasis on formative evaluation of learning, extending evaluation efforts beyond achievement to cover other valued outcomes, and that alternative and authentic techniques be used to complement the traditional paper and pencil evaluation instrument. The difficulty in this study lies in applying these considerations within the confines of a regimented assessment requirement. While the requirements of good assessment practices can be pursued, the opportunities of using other recognised methods of assessment are limited.

Before the process of planning, designing and constructing assessment can begin, it is absolutely necessary to have unambiguous learning outcomes or objectives and for the teacher or assessor to be very clear about what the actual behaviour in that outcome means (Kizlik, 2004d). Therefore, the development of the assessment framework consisted primarily of identifying the learning outcomes for each diploma, rationalising these learning outcomes, then recombining them to form a set of learning outcomes that not only meets the requirements of each diploma but also provides a strong focus on learning for both teacher and student. These assessment outcomes are jointly provided by the interpretation of the Dip Tech course prescription learning outcomes and the associated Unit Standard learning outcomes. Associated with these learning outcomes must be performance criteria that clearly indicate how the student is to demonstrate their knowledge or understanding. The knowledge of the expected skills profile of a diploma graduate will also underpin the assessment objectives.

Relevant extracts from the Dip Tech documentation confirms the relationship between the Dip Tech programme and the NDE (NZNDE) in that a credit for the NDE can be gained whilst studying for the Dip Tech.

> This endorsement has achievement-based assessment and its academic standard is roughly equivalent to the existing NZCE. Also a pathway has been provided for the better students to gain access to one of the university engineering schools. However, in order to capture as much of the market as possible students can also gain a NZNDE in two years while studying for this endorsement, provided they choose the correct options.
>
> MYTEC Diploma of Technology Programme documentation

Each Dip Tech course document provides information regarding the NZCE courses it replaces, the NZNDE equivalent, and assessment information. In the following extract from the DC Circuits course documentation, it can be seen that the Dip Tech Direct Current Circuits course replaces the NZCE DC Circuits course and part of the electronic analysis course. It also subsumes or is equivalent to the unit standard DC Concepts course and part of the unit standard Electronic Analysis course.

> Course Overview
> Replaces:
> Electrical Fundamentals – DC Circuits and part of Electronic Circuit Analysis and Subsystems 4208.
> NZNDE Equivalent:
> Describe and apply direct current concepts in electrical engineering, (16964, level 4, 12 credits). For the 4208 part the NZNDE equivalent is Describe and Apply Electronic Analysis Concepts (16968, level 5, 12 credits).
>
> DC Circuits course documentation

5.2.2 Programme Goals

Because the Dip Tech is the primary qualification, the goals for the programme are available from the programme documentation in the form of a graduate profile. Such a profile lists the specific outcomes that a graduate will be able to do. Although these outcomes do make reference to some fundamental employability skills such as working as a team member and communication, many of the skills desired by future employers are not addressed.

Table 5.1

Graduate Profile for the Diploma in Technology, Electronics Endorsement

A graduate of the Diploma in Technology with an Electronics endorsement will be able to:

- Given a specification, produce an electronic solution that fulfils the requirements.
- Demonstrate basic programming skills.
- Update themselves with the on-going developments in electronics.
- Demonstrate safe practice in the systems produced and promote safe practices.
- Work effectively as a team member.
- Follow documented instructions accurately and with minimum supervision.
- Diagnose and repair faults on equipment or systems relevant to Computer Engineering.
- Formulate ideas and present these effectively.
- Use computers effectively in a wide variety of engineering settings.
- Demonstrate adequate mathematical knowledge.
- Communicate effectively (both written and orally) with colleagues both senior and junior.
- Research the literature and the Internet in their chosen area to find specific information.
- Identify and respond to technical problems in an electronics workplace.
- Understand the theoretical principles underlying the practical applications.

Within the confines of this study, most criteria were firmly established either in the programme documentation, the course documentation and/or the unit standard.

Criteria that need to be considered…

- Students can attain the NDE (NZNDE) at the same time as the Dip Tech.
- The combined learning outcomes developed for each of the Dip Tech courses should provide students with the focus to meet the competency-based assessment criteria for the equivalent unit standards as well as meeting the obligations of the achievement-based assessment.

- The learning outcomes stated in the unit standard and the Dip Tech course should drive the learning and assessment content.

5.2.3 Background to the Diplomas

In order to fully understand the relationship and emphasis of the courses involved in this study, it is beneficial to consider the background to the course composition of the diplomas. The original two year full-time NZCE programme had four electrical/ electronic courses programmed for the first year with a second year course that in general dealt with advanced theory applications associated with principles from the four first year courses. For the sake of simplicity, the names used here are general descriptive names.

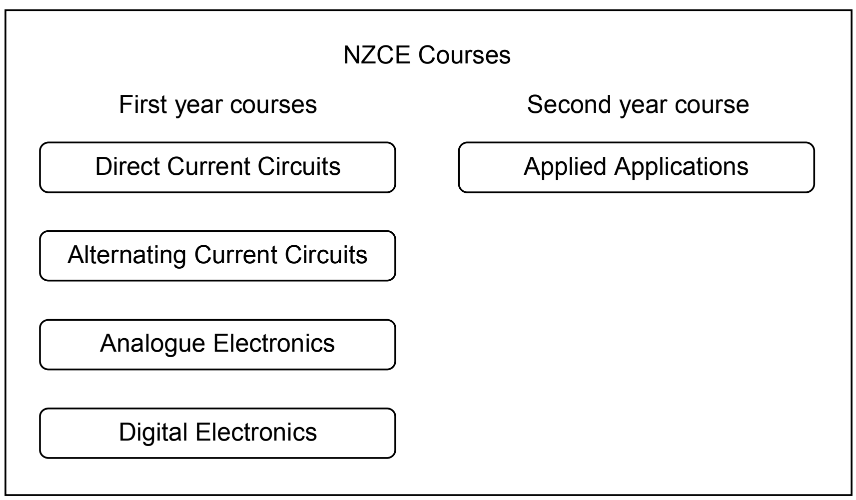

Figure 5.1. Identity of relevant NZCE courses

Each of the NZCE course prescriptions contained the content of the course written in a full descriptive manner. Although this emphasis clearly outlined the teaching material, it can be argued that one of the problems was that the outcomes or objectives associated with the NZCE documentation were not clearly identified as 'performance' outcomes. When the NZCE was disestablished, the NDE unit standards were established from these five courses with an emphasis on learning/performance outcomes in the form of elements and performance criteria. The NDE unit standards each had a learning 'value' of 12 credits and 120 hours of learning and this corresponded with the 'value' of the original NZCE courses.

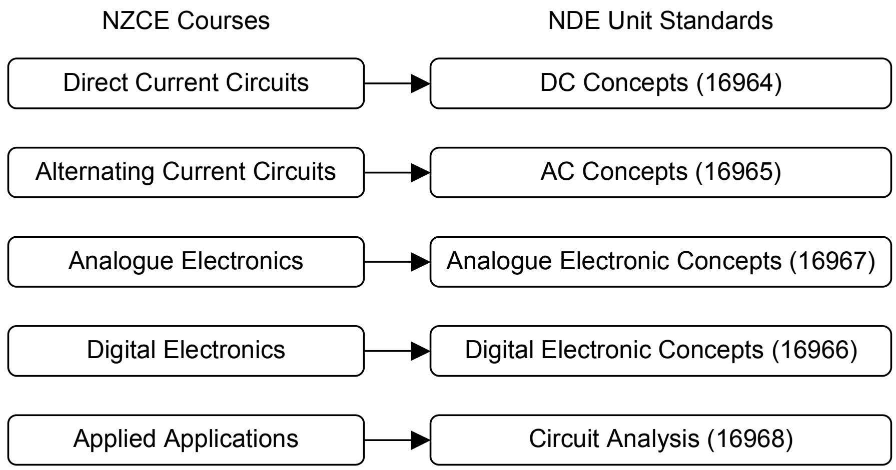

Figure 5.2. Transfer of NZCE courses to NDE unit standards

Each of the original five NZCE courses was replaced with a unit standard but with a different textual approach that was informally described by some colleagues as 'there is nothing to teach'. An example of this can be seen in the Analogue Electronic Concepts unit standard.

Table 5.2

Content of the Unit Standard 16967, Elements and Performance Criteria

---

element 1

Describe analogue electronic concepts.

Range: concepts - characteristics and operation of two terminal and three terminal semiconductor devices; function and main parameters of an operational amplifier.

performance criteria

1.1 The description provides a coherent statement of the concepts.

Range: description includes - main features, purpose, use of concepts.

1.2 The description identifies the characteristics of associated scientific rules, logic, and formulae.

1.3 Supporting practical examples provide valid illustrations of the concepts.

element 2

Apply analogue electronic concepts in given applications.

Range: applications - application of semiconductor diodes in unregulated power supplies; general purpose operational amplifier configurations and applications; use of transistors in simple amplification and switching circuits and determination of impedances, biasing, gain/band width; direct current power regulators; system integration of above components.

performance criteria

2.1 The selected principles, rules, formulae, and data are appropriate for the application requirement.

Range: requirements include any of - tests, experiments, problems.

2.2 The application process demonstrates valid and logical use of the technology concepts, rules, formulae, and data.

Range: processes include any of - mathematical or logical manipulation, computation, presentation.

2.3 The application results reflect valid use, or interpretation, or adaption of the technology concepts and formulae.

Range: results include any of - the behaviour, properties of systems, equipment, components, materials.

If the performance criteria are put to one side and only the two elements are considered, then the 120 hours of learning is contained within the phrases "describe analogue electronic concepts" and "apply analogue electronic concepts in given applications", each with their respective range statements. If the focus is placed only on these two statements, then it is understandable why teachers would not 'see' any depth of teaching or learning.

At the same time as the NZCE courses were transferred into unit standards, the local institution created the Dip Tech programme. The MYTEC diploma criteria required each course to have a learning 'value' of 15 credits or 150 learning hours, so the five 12 credit equivalent NZCE courses were transferred into four 15-credit diploma courses. This was a relatively straightforward process of transferring the four year 1 courses directly across into the four Dip Tech courses and then splitting the Core (Applied) Electronics course four ways and combining one part into each of the four courses.

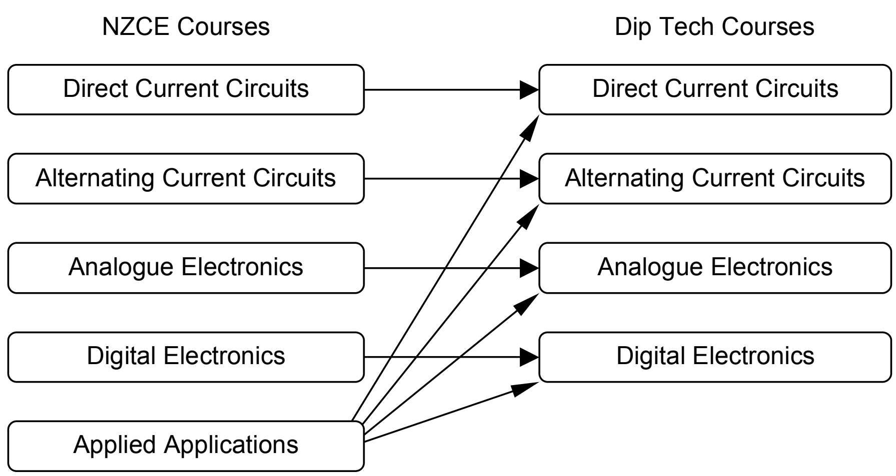

Figure 5.3. Transfer of NZCE courses to Dip Tech courses

While the unit standards are relatively simplistic in their wording, (e.g., "describe analogue electronic concepts" and "apply analogue electronic concepts in given applications"), the Dip Tech prescriptions are much more detailed. For example the Analogue Electronics course has 10 learning outcomes, each of which contains a significant amount of material and some of these 10 outcomes contain more words and descriptions than an NDE unit standard does for the whole course. The example here is from the Analogue Electronics course.

Table 5.3

Content of the Analogue Electronics, Learning Outcome1 and Performance Criteria

---

Learning Outcome 1

Describe the operation, characteristics and basic application of various two terminal semiconductor devices. Apply semiconductor diodes to simple unregulated power supplies.

(Range: rectifier diode, Schottky diode.)

Performance Criteria

1.1 Conduction through semiconductor material and a p-n junction is explained.

1.2 The characteristics and specifications of PN Junction devices are explained.

1.3 Rectification is explained.

(Range: components, ripples, half wave and full wave rectification)

1.4 Typical applications of devices explained with the aid of a simple circuit and waveform diagrams.

(Range: DC PSU - unregulated full wave with and without capacitor input filtering; signal clipping using diodes (silicon, Schottky or zeners.))

The learning outcomes for each course are either embodied in the Learning Outcomes and Performance Criteria section of the course documentation for each of the Dip Tech courses, or in the Elements and Performance Criteria section for each of the NDE Unit Standards. Although the words ‘element’ and ‘performance criteria’ are used in the Unit Standard, and the words ‘learning outcome’ and ‘performance criteria’ are used in the Dip Tech prescription, the actual writing of the content for each diploma is quite different. In each of the NDE Unit Standards the elements can be considered succinct, but they do have performance criteria that contain specific statements of performance which are used to describe the type of response that the student is expected to make and not detail the theoretical content. In the Dip Tech courses the elements are more detailed and the performance criteria could be considered to be more of an extension of the content of the outcome and are used to further specify the theoretical content of that element. Hence they do not describe the type of response or specify how well the students must perform. Whether or not one approach is a correct interpretation and the other an incorrect interpretation, or whether both are correct interpretations, is a matter of confusion. In the brochure put out by the New Zealand Qualifications Authority (2005), Principle 1.3 states "Performance criteria do not express outcomes. They indicate the minimum evidence to consider when making a judgement as to whether the candidate has achieved the outcomes of the element and, therefore, the standard" and Principle 2.1 states "Performance criteria are critical guidelines to the type of evidence that must be collected to make a judgement about performance".

Even though the Dip Tech courses and the NDE courses have each evolved from the NZCE courses, the major difference in the wording has been influenced by the emphasis on the method of assessment. However, irrespective of the method of assessment, both courses should have clear and well-defined learning goals and outcomes in order to provide a clear focus for both instruction and assessment. Although the two prescriptions appear to be quite different and yet because each was derived from NZCE courses, it should be possible to demonstrate a correlation between the two so that the summative assessment for the Dip Tech course could be developed so that it can also be used to determine competency for the unit standard.

Although the Dip Tech course prescriptions are more detailed, there is a tendency for the learning outcomes to use words that can leave some confusion. An important first step in the process of rationalisation and correlation between the two diplomas was to understand the type of wording used for the elements and learning outcomes. Each should have a clearly defined condition, behavioural verb and criteria. The 'condition' should describe the circumstances, commands, materials, directions, etc. under which the behaviour or student performance is to be performed. The 'behavioural' verb is the action word that suggests an observable feature of the students' performance and the 'criteria' is a statement that specifies how well the student must perform the task. Between the two diplomas several behavioural verbs are used. What do these words mean?

5.2.4 Behavioural Verbs

The definitions of behavioural verbs are an important factor of learning outcomes and performance criteria. In fact they are the heart of learning outcomes and lesson plans and if used properly, they are a highly effective way to describe a student's response. They can indicate and communicate to students the specific and observable product or action intended in the context of the learning outcomes (Kizlek, 2004b). Between the two diplomas, the behavioural verbs apply, analyse, demonstrate, describe, explain and understand are used.

The New Oxford Dictionary of English (Electronic Version) defines the following meanings for the behavioural verbs as used in the prescriptions.

- Apply - to use a rule or methodology to convey the analysis of a problem situation and/or its solution.
- Analyse - examine methodically and in detail the constitution or structure of (something, especially information); discover or reveal (something) through such examination; identify and measure the chemical constituents of (a substance or specimen)
- Demonstrate - give a practical exhibition and explanation of (how a machine, skill, or craft works is performed).
- Describe - To name all of the necessary group of objects, properties of objects or properties of events that are relevant to the specified situation.
- Explain - make (an idea, situation, or problem) clear to someone by describing it in more detail or revealing relevant facts or ideas.
- Understand - perceive the significance, explanation, or cause of something.

With a reference to the document 'Major Categories in the Taxonomy of Educational Objectives: Categories in the Cognitive Domain: (with Outcome-Illustrating Verbs)' (Bloom, 1956), the behavioural verbs are defined as…

- Apply is listed under Application: The use of previously learned information in new and concrete situations to solve problems that have single or best answers.
- Analyse is listed under Analysis: The breaking down of informational materials into their component parts, examining (and trying to understand the organizational structure of) such information to develop divergent conclusions by identifying motives or causes, making inferences, and/or finding evidence to support generalizations.
- Demonstrate – not listed
- Describe, Explain and Understand are all listed under Comprehension: Grasping (understanding) the meaning of informational materials.

When reference is made to *Taxonomy of Educational Objectives* (Wikipedia, n.d.), the meanings of the behavioural verbs are…

- Application (Apply): Using new knowledge. Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.
- Analysis (Analyse): Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.
- Comprehension (Describe, Explain and Understand): Demonstrative understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.

With reference to 'Definitions of Behavioural Verbs for Learning Objectives' (Kizlik, 2004b), the following definitions are obtained…

- Apply (a rule): "To state a rule as it applies to a situation, object or event that is being analysed. The statement must convey analysis of a problem situation and/or its solution, together with the name or statement of the rule that was applied”.

- Analyse: (Definition not given)
- Demonstrate: “The student performs the operations necessary for the application of an instrument, model, device, or implement. NOTE: There is a temptation to use demonstrate in objectives such as, ‘the student will demonstrate his knowledge of vowel sounds.’ As the verb is defined, this is improper use of it.”
- Describe: “To name all of the necessary categories of objects, object properties, or event properties that are relevant to the description of a designated situation.”
- Explain: (Definition not given)
- Understand: (Definition not given)

It is suggested that some of the behavioural verbs used in the Dip Tech prescription do not seem to fit in well into a classroom environment. The use of the word ‘demonstrate’ suggests an individual, practical exercise that would need to be observed by the teacher. An overuse of this word, for example, in ‘demonstrate an understanding’, could prove problematic for both teacher and student. However, it is in the Wikipedia information that a definition for ‘demonstrate’ can be deduced even though it is not listed as a behavioural verb in the taxonomy. Demonstrate (‘demonstrate understanding’ or ‘demonstrate an understanding’) is used in the meaning or interpretation of comprehension and this serves to give a focus for this word. Although teacher experience can usually interpret an outcome that is not well defined, if students are to use outcomes to focus their learning, then the defining of learning outcomes and the associated performance criteria should be clear and unambiguous.

5.2.5 Performance Criteria

The theoretical model category - Assessment of Unit Standards: NZQA, outlines several important principles that need to be considered. The element(s) in the standard identify the outcomes against which the candidate is assessed. All the contexts specified in a range statement must be considered when making an assessment decision unless they are elective within a range statement, for example the expression 'may include but not limited to'. Performance criteria are associated with elements but rather than express outcomes, they indicate the minimum evidence to consider when making a judgement as to whether the candidate has achieved the outcomes of the element and, therefore, the standard. The use of the expression 'performance criteria' in the achievement based Dip Tech courses is more problematic because the term is not so well defined in the related NZQA literature. It is suggested that the Dip Tech performance criteria are more focused on criteria for learning rather than how a student can demonstrate their understanding and application at various levels of achievement.

5.2.6 Rationalisation of Learning and Assessment Outcomes

In order to develop a framework of the outcomes for the combined Dip Tech and Unit Standard courses, it was necessary to rationalise the assessment criteria for each course. The purpose of this rationalisation was to demonstrate any equivalence between the quite different wording between the Unit Standards and the Dip Tech courses. If this equivalence does exist as it could reasonably be expected, then a list of clear learning outcomes could be generated for each Dip Tech course that would give learning and assessment focus for both diplomas. The rationalisation followed the following progression.

1. The outcomes for each of the four core electrical/electronic Unit Standards as well as the Core Electronics Unit Standard were developed into an expanded list of outcomes from the single statement and the associated range statement. The Unit Standards were rationalised using the guidelines from *Best practice principles for the assessment of unit standards*. (New Zealand Qualifications Authority, 2005). This document promotes three principles and these are summarised as…
    1) Assessment Design – should target the element (i.e. the lowest level of assessment priority in the unit standard that is expressed in terms of an

outcome) and not the performance criteria (which is how the competency is to be demonstrated), and consider the whole content of the range statement when an assessor makes a decision of competence.

2) Assessment Decisions – must be based on all the performance criteria for a given learning outcome.

3) Sufficiency of Evidence – requires only the least amount of evidence that is needed for a valid judgement of competency, i.e. do not over assess.

2. The outcomes for the Unit Standard Core Electronics (US16968) were initially divided into four groups that matched the content of the four Dip Tech courses. The learning outcomes were then assigned to the four Dip Tech courses to produce individual lists of unit standard outcomes that are subsumed by each of these four courses.
3. The Learning Outcome criteria for the four core electrical / electronic Dip Tech courses were summarised and used to produce a list of learning outcomes for each course. These courses are Direct Current Circuits, Alternating Current Circuits, Digital Electronics and Analogue Electronics.
4. A cross reference of Dip Tech outcomes and Unit Standard learning outcomes was produced for each Dip Tech course and these in turn were associated with a learning topic from the Dip Tech curriculum.
5. A combined summary of learning outcomes by topic that encompasses the associated unit standard outcomes was produced for each Dip Tech course.

Underlying the whole process was the desire to incorporate into the model those learning principles that worked towards the promotion of concrete learning experiences for the students and for the students to have greater control of their learning.

5.2.7 Rationalisation of Assessment Criteria for Unit Standards

The structure of each of the five Unit Standards is very similar. There are two elements, and each has a set of performance criteria. Element 1 uses the behavioural verb 'describe' and is more of a theoretical approach (e.g., "Describe direct current concepts in electrical engineering") while element 2 uses the behavioural verb 'apply' and is more of a practical approach (e.g., "Apply direct current concepts in given applications of electrical engineering"). The performance criteria are well written descriptors of performance and follow the standard or example suggested by NZQA.

The process of breaking apart the unit standard included…

- Understand and state the meaning of the performance outcome for each element.
- Splitting the range of the element into clearly identifiable outcomes.
- Simplify the performance criteria in order to provide a clear focus on the standard for assessment performance.
- Rewrite the list of performance outcomes with the unit standard code to produce a list of identifiable learning outcomes.

During the development stages of the assessment framework, this process of disassembling the course prescriptions and standards and then reassembling the data into sets of course outcomes, was carried out for each of the four Dip Tech courses in order to produce a final list of outcomes for learning and assessment. The process was simplified because of the similarity of the five unit standards (i.e. element 1 – describe…, and element 2 – apply…) and also in that the performance criteria for each of the 'describe' elements and the 'apply' elements are very similar in their wording.

The example used in this chapter to illustrate the process of taking the data from the elements of the Unit Standards and then combining with data for the associated Dip Tech course, is Unit Standard DC Concepts (16964) course and part of Core

Electronics (US 16968) combining with data from the Dip Tech DC Circuits course. The process for the other three Dip Tech courses is summarised in the Appendices.

5.2.8 Outcomes – DC Concepts (16964)

Element 1 of the Unit Standard document is…

element 1

Describe direct current concepts in electrical engineering.

Range: concepts

electrotechnology fundamentals - definitions of voltage, current, power; properties of resistance in direct current (d.c.) circuits; Kirchoff's Laws; simple electrostatics and capacitance; electromagnetism - Faraday's and Lenz' Laws, self and mutual inductance.

performance criteria

1.1 The description provides a coherent statement of the concepts.

Range: description includes - main features, purpose, use of concepts.

1.2 The description identifies the characteristics of associated scientific rules, logic, and formulae.

1.3 Supporting practical examples provide valid illustrations of the concepts.

The expansion of the element objective and the associated range statement commenced with the identification and listing of the associated theory groups within the range statement. Each of these items were then preceded with 'Describe' which is the main action contained within the learning element. Where the range statement did not include a noun (e.g., definitions, properties), the word concept was introduced to improve the focus of the outcome. Hence, the following list of outcomes was developed.

element 1

a. Describe the definitions of voltage, current, power.

b. Describe the properties of resistance in direct current (d.c.) circuits.

c. Describe the concept of Kirchoff's Laws.

d. Describe the concepts of simple electrostatics and capacitance.

e. Describe the concepts of Faraday's and Lenz' Laws.

f. Describe the concepts of self and mutual inductance.

When the performance criteria are considered, they in turn can be simplified to provide clearer criteria. For each of the element outcomes, performance statements should be such that the description…

performance criteria

1.1 Provides a coherent statement.

1.2 Identifies characteristics.

1.3 Is supported by a valid illustration (where applicable).

Element 2 of the same Unit Standard document is presented in the same manner except that the focus is on the verb 'apply'.

element 2

Apply direct current concepts in given applications of electrical engineering.

Range: electrical engineering applications - analysis of voltage, current and power in d.c. circuits; behaviour of voltage and current in mixed networks of resistance and inductance (LR) and resistive and capacitive (LC) networks; applications of voltage dividers, resistivity and magnetic circuits.

performance criteria

2.1 The selected principles, rules, formulae, and data are appropriate for the application requirement.

Range: requirements include any of - tests, experiments, problems.

2.2 The application process demonstrates valid and logical use of the technology concepts, rules, formulae, and data.

Range: processes include any of - mathematical or logical manipulation, computation, presentation.

2.3 The application results reflect valid use, or interpretation, or adaption of the technology concepts and formulae.

Range: results include any of - the behaviour, properties of systems, equipment, components, materials.

In a similar manner to that previously described for element 1, the element objective and the associated range statement was expanded to produce the following list of outcomes.

element 2

a. Apply the analysis of voltage, current and power in d.c. circuits.

b. Apply the behaviour of voltage and current in mixed networks of resistance and inductance.

c. Apply the behaviour of voltage and current in mixed networks of resistive and capacitive.

d. Apply the applications of voltage dividers.

e. Apply the applications of resistivity.

f. Apply the applications of magnetic circuits

The performance criteria for each of these separate statements should be that the description demonstrates…

performance criteria

2.1 Appropriateness of principles/rules/formulae/data through tests, experiments or problems

2.2 Valid and logical use of concepts/rules/formulae/data through manipulation, computation or presentation

2.3 Valid use or interpretation or adaptation of concepts and formulae through behaviour, properties, components or materials.

The outcomes from this process were then associated with a code consisting of the unit standard number, the element number and the letter code, and then combined into a single list.

Table 5.4

Final List of Principal Outcomes for Unit Standard DC Concepts (16964)

US	**Assessment Criteria**
16964.1.a	Describe the definitions of voltage, current, power.
16964.1.b	Describe the properties of resistance in direct current (d.c.) circuits.
16964.1.c	Describe the concept of Kirchoff's Laws.
16964.1.d	Describe the concepts of simple electrostatics and capacitance.
16964.1.e	Describe the concepts of Faraday's and Lenz' Laws.
16964.1.f	Describe the concepts of self and mutual inductance.
16964.2.a	Apply the analysis of voltage, current and power in d.c. circuits.
16964.2.b	Apply the behaviour of voltage and current in mixed networks of resistance and inductance.
16964.2.c	Apply the behaviour of voltage and current in mixed networks of resistance and capacitance.
16964.2.d	Apply the applications of voltage dividers.
16964.2.e	Apply the applications of resistivity.
16964.2.f	Apply the applications of magnetic circuits

This process was completed for each of the four, first year NDE Unit Standards.

5.2.9 Assign the Circuit Analysis (US 16968) Outcomes

The process for the breaking apart of this unit standard and creating a list of expanded and simplified learning and assessment outcomes is the same as previously discussed except that it has to be divided and each relevant section associated with the four Dip Tech courses (i.e. Direct Current Circuits, Alternating Current Circuits, Analogue Electronics, and Digital Electronics).

The unit standard provides for element 1…

element 1

Describe circuit analysis concepts.

Range: concepts

electrical engineering fundamentals - Thevenin's and Norton's theorems; voltage, current and power in networks;

electronic components - operating and performance characteristics of signal amplifiers, operational amplifiers, active and passive filters, power and power switching regulators, digital to analogue and analogue to digital convertors.

performance criteria

1.1 The description provides the characteristics of the concepts.

Range: characteristics include - purpose, scope, use of concepts.

1.2 The description identifies the content and functions of associated rules, logic, and formulae.

1.3 Supporting examples provide valid illustrations of the concepts.

Range: illustrations include theoretical or practical types.

And for element 2…

element 2

Apply **circuit** analysis to electrotechnology applications.

Range: applications

electrotechnology - network analysis of voltage, current and power in direct current (d.c.) and alternating current (a.c.) signal circuits; amplifier gain and feedback; single order filter analysis;

electronic circuits - analysis of common analogue and digital components including amplifiers, operational amplifiers, power regulators, digital to analogue and analogue to digital convertors.

performance criteria

2.1 The selected information sources are relevant to the given application.

Range: sources include any of - scientific texts, manufacturers data, test or experimental measurements.

2.2 The selected principles, rules, formulae, and data are relevant to the application requirement.

Range: requirements include any of - analyses, tests, experiments, theoretical or practical problems.

2.3 The application process demonstrates valid and logical use of the technology concepts, rules, formulae and data.

Range: processes include any of - mathematical or logical interpretation, manipulation, computation, presentation.

Given that the performance criteria for the 'describe' and 'apply' elements are similar for all the considered Unit Standards, the specific learning and assessment outcomes for this Unit Standard can be identified and associated with the relevant Dip Tech course.

Table 5.5

Assessment Outcomes for Circuit Analysis Unit Standard Grouped to Match Dip Tech Courses

Core Electronics (16968) Assessment Outcomes		**Subsumed within Dip Tech Course…**
16968.1.a	Describe the fundamentals of Thevenin's and Norton's theorems.	ECTE401 Direct Current Circuits
16968.1.b	Describe the fundamentals of voltage, current and power in networks.	
16968.2.a	Apply circuit analysis to network analysis of voltage, current and power in direct current (d.c.) signal circuits.	
16968.1.f	Describe the operating and performance characteristics of passive filters.	ECTE402 Alternating Current Circuits
16968.2.b	Apply circuit analysis to network analysis of voltage, current and power in alternating current (a.c.) signal circuits.	
16968.1.h	Describe the operating and performance characteristics of power switching regulators.	ECTE403 Digital Electronics
16968.1.i	Describe the operating and performance characteristics of digital to analogue and analogue to digital convertors.	
16968.2.h	Apply circuit analysis to digital to analogue and analogue to digital convertors.	
16968.1.c	Describe the operating and performance characteristics of signal amplifiers.	ECTE501 Analogue Electronics
16968.1.d	Describe the operating and performance characteristics of operational amplifiers.	
16968.1.e	Describe the operating and performance characteristics of active filters.	
16968.1.g	Describe the operating and performance characteristics of power regulators.	
16968.2.c	Apply circuit analysis to amplifier gain and feedback.	
16968.2.d	Apply circuit analysis to single order filter analysis.	
16968.2.e	Apply circuit analysis to amplifiers.	
16968.2.f	Apply circuit analysis to operational amplifiers.	
16968.2.g	Apply circuit analysis to power regulators.	

These learning and assessment performance outcomes were then added to or subsumed into the relevant Dip Tech Course. The example here is the Direct Current Circuits course where the number 16964 precedes those from the DC Concepts Unit Standard and 16968 precedes those from the Circuit Analysis Unit Standard…

Table 5.6

Competency Assessment Outcomes that are Subsumed into the Dip Tech Direct Current Circuits course

Unit Standard	**Competency Assessment Outcome**
16964.1.a	Describe the definitions of voltage, current, power.
16964.1.b	Describe the properties of resistance in direct current (d.c.) circuits.
16964.1.c	Describe the concept of Kirchoff's Laws.
16964.1.d	Describe the concepts of simple electrostatics and capacitance.
16964.1.e	Describe the concepts of Faraday's and Lenz' Laws.
16964.1.f	Describe the concepts of self and mutual inductance.
16964.2.a	Apply the analysis of voltage, current and power in d.c. circuits.
16964.2.b	Apply the behaviour of voltage and current in mixed networks of resistance and inductance.
16964.2.c	Apply the behaviour of voltage and current in mixed networks of resistance and capacitance.
16964.2.d	Apply the applications of voltage dividers.
16964.2.e	Apply the applications of resistivity.
16964.2.f	Apply the applications of magnetic circuits
16968.1.a	Describe the fundamentals of Thevenin's and Norton's theorems.
16968.1.b	Describe the fundamentals of voltage, current and power in networks.
16968.2.a	Apply circuit analysis to network analysis of voltage, current and power in direct current (d.c.) signal circuits.

5.2.10 Rationalisation of the Dip Tech Course Outcomes

The four Dip Tech courses were also restructured to produce a list of clearly identifiable learning outcomes based on the range statement given in the Dip Tech course documentation. These learning outcomes were taken from the 'learning outcome' statement for each section and not from the performance criteria.

Table 5.7

Specific Learning Outcomes for Direct Current Circuits

Learning Outcome Number	Statement of Learning Outcome
1	Understand concepts of emf, voltage, current, energy and power.
2	Explain the concept of resistance and define Ohms Law.
3	Analyse circuits containing resistors in series, parallel and series-parallel.
4	Apply Kirchoff's laws to analyse simple resistor networks.
5	Apply voltage dividers to practical applications.
6	Apply concept of resistivity to practical applications.
7	Apply concept of temperature coefficient of resistance to practical applications.
8	Demonstrate an understanding of the theory and application of the Wheatstone bridge circuit.
9	Explain the operation of a capacitor in a dc circuit using a simple constructional model and basic electrostatics.
10	Demonstrate understanding of the relationships between current, voltages and time when a capacitor is charged/discharged in a simple RC circuit.
11	Demonstrate understanding of basic electromagnetism.
12	Demonstrate understanding of Faraday's Laws and Lenz's Law.
13	Demonstrate an understanding of self-induction.
14	Demonstrate an understanding of inductive DC transients and suppression methods.
15	Demonstrate an understanding of mutual induction.
16	Apply network theorems.

5.2.11 Cross Match of Learning Outcomes

The learning outcomes from the Dip Tech course and the outcomes from the full and part Unit Standards were then cross-matched against a topic identifier.

Table 5.8

Cross-Matched Learning Outcomes for Direct Current Circuits and Unit Standard 16964/part 16968

Topic	Unit Standard 16964 Outcomes		Dip Tech Direct Current Outcomes	
A	16964.1.a	Describe the definitions of voltage, current, power.	1	Understand concepts of emf, voltage, current, energy and power.
	16964.1.b	Describe the properties of resistance in direct current (d.c.) circuits.	2	Explain the concept of resistance and define Ohms Law.
B	16964.2.a	Apply the analysis of voltage, current and power in d.c. circuits.	3	Analyse circuits containing resistors in series, parallel and series-parallel.
	16964.2.d	Apply the applications of voltage dividers.	5	Apply voltage dividers to practical applications.
C	16964.2.e	Apply the applications of resistivity.	6	Apply concept of resistivity to practical applications.
			7	Apply concept of temperature coefficient of resistance to practical applications.
			8	Demonstrate an understanding of the theory and application of the Wheatstone bridge circuit.
D	16964.1.c	Describe the concept of Kirchoff's Laws.	4	Apply Kirchoff's laws to analyse simple resistor networks.

E	16964.1.d	Describe the concepts of simple electrostatics and capacitance.	9	Explain the operation of a capacitor in a dc circuit using a simple constructional model and basic electrostatics.
	16964.2.c	Apply the behaviour of voltage and current in mixed networks of resistance and capacitance.	10	Demonstrate understanding of the relationships between current, voltages and time when a capacitor is charged/discharged in a simple RC circuit.
F	16964.1.e	Describe the concepts of Faraday's and Lenz' Laws.	12	Demonstrate understanding of Faraday's Laws and Lenz's Law.
	16964.1.f	Describe the concepts of self and mutual inductance.	13	Demonstrate an understanding of self-induction.
	16964.2.b	Apply the behaviour of voltage and current in mixed networks of resistance and inductance.	15	Demonstrate an understanding of mutual induction.
			14	Demonstrate an understanding of inductive DC transients and suppression methods.
G	16964.2.f	Apply the applications of magnetic circuits	11	Demonstrate understanding of basic electromagnetism.
	Unit Standard 16968 Outcomes		**Dip Tech Direct Current Outcomes (cont)**	
H	16968.1.a	Describe the fundamentals of Thevenin's and Norton's theorems.	16	Apply network theorems.
	16968.1.b	Describe the fundamentals of voltage, current and power in networks.		
	16968.2.a	Apply circuit analysis to network analysis of voltage, current and power in direct current (d.c.) signal circuits.		

Once this table was completed for each of the four Dip Tech courses, it was clear that the two sets of outcomes did not conflict with each other, but rather complemented and clarified each other. Where there was an omission in one set, the inclusion of extra topics in the other set presented a clearer focus for learning.

Two examples of this complementation of cross-matched outcomes are…
Section C, which contains “16964.2.e Apply the applications of resistivity”. A learning exercise involving this application would usually include the use of strain gages for load measurement, which in turn would necessitate the learning of items 6, 7, and 8 from the Dip Tech outcomes list.

Section H, which contains “Apply network theorems” in the Dip Tech list. This by itself is somewhat ambiguous but when matched with the three items from the Unit Standard, there is a much clearer focus for learning.

The next step in the process of rationalisation was to consider the outcomes within each section from each column, i.e. from both the Unit Standard and the Dip Tech courses and merge the two into a final set of combined outcomes. This approach produced a set of outcomes to be used as a focus for learning and assessment for learning, and which would ensure that the assessment criteria for both the Dip Tech course and the associated Unit Standards are met. Care needed to be taken during learning and assessment to ensure that undue emphasis was not placed on a student having to meet the competency requirement of any outcome that is not specifically stated in a Unit Standard.

Table 5.9

Combined Summary of Learning Outcomes for Direct Current Circuits and Unit Standard 16964/part 16968

A	**Basic Concepts - Describe** Describe concepts of emf, voltage, current, energy and power; describe the concept of resistance and define Ohms Law; describe the properties of resistance in direct current (d.c.) circuits.
B	**D.C. Circuits – Apply** Apply the analysis of voltage, current and power in d.c. circuits; apply the analysis of circuits containing resistors in series, parallel and series-parallel; apply the applications of voltage dividers.
C	**Resistivity/Temp Coeff – Apply** Apply the applications (concepts) of resistivity to practical applications; demonstrate an understanding of the theory and application of the Wheatstone bridge circuit. **Temp. Coeff. – Apply** Apply the concept of temperature coefficient of resistance to practical applications.
D	**Kirchoff's Laws – Describe and apply** Describe the concept of Kirchoff's Laws; apply Kirchoff's laws to analyse simple resistor networks.
E	**Electrostatics – Describe** Describe the concepts of simple electrostatics and capacitance; explain the operation of a capacitor in a dc circuit using a simple constructional model and basic electrostatics. **RC Circuits – Apply** Apply the behaviour of voltage and current in mixed networks of resistance and capacitance; demonstrate understanding of the relationships between current, voltages and time when a capacitor is charged/discharged in a simple RC circuit.

F	**Faraday's and Lenz' Laws – Describe** Describe the concepts of Faraday's and Lenz' Laws; demonstrate understanding of Faraday's Laws and Lenz's Law. **Self and Mutual Inductance – Describe and apply** Describe the concepts of self and mutual inductance and demonstrate an understanding of self and mutual induction; apply the behaviour of voltage and current in mixed networks of resistance and inductance; demonstrate an understanding of inductive DC transients and suppression methods.
G	**Magnetic circuits – Apply** Apply the applications of magnetic circuits and demonstrate understanding of basic electromagnetism.
H	**Circuit Theorems – Describe and apply** Describe the fundamentals of Thevenin's and Norton's theorems; describe the fundamentals of voltage, current and power in networks; Apply circuit analysis to network analysis of voltage, current and power in d.c. circuits.

The final part of the process was to associate with the summary list of learning outcomes the performance criteria for the Dip Tech course. Although these performance criteria could be considered to be an extension of the learning outcomes rather than how the student could be expected to demonstrate their learning, the result is a list of specific expected learning outcomes that become a succinct focus. It can be used as a checklist for the teacher in terms of the provision of learning experiences, and for the students to use as part of the feedback for their learning.

Table 5.10

Specific Expected Learning Outcomes for Direct Current Circuits and Unit Standard 16964/part 16968

Specific Expected Learning Outcomes

A Basic Concepts - Describe

Describe concepts of emf, voltage, current, energy and power; describe the concept of resistance and define Ohms Law; describe the properties of resistance in direct current (d.c.) circuits.

- Describe electric current and state its symbol and unit
- Describe emf and state its symbol and unit
- Describe resistance and state its symbol and unit
- Describe electrical energy and state its symbol and unit
- Describe electrical power and state its symbol and unit
- Define Ohm's Law in words and state the three variations of its formulae
- Apply Ohm's Law in calculations, including multiples and sub-multiples of units

B D.C. Circuits – Apply

Apply the analysis of voltage, current and power in d.c. circuits; apply the analysis of circuits containing resistors in series, parallel and series-parallel; apply the applications of voltage dividers.

- Understand the properties of series and parallel circuits.
- Perform calculations on series/parallel resistor networks.
- Apply Ohms Law to determine branch currents and volt drops across any component in a series-parallel resistor network.
- Verify resistor network calculations by measurement.
- Calculate power dissipation in individual resistors and in a complete circuit.
- Define the term Voltage Divider .
- Calculate and verify by measurement the output voltages of given voltage divider circuits.
- Apply voltage divider formula to simple real world circuits.
- Explain and observe in practice the effect of applying an external load.
- Give with suitable reasons examples of typical applications.

- Determine suitable resistor values for a given supply and output voltage using E series resistors.

C Resistivity – Apply

Apply the applications (concepts) of resistivity to practical applications; demonstrate an understanding of the theory and application of the Wheatstone bridge circuit.

- Appreciate that resistance depends on four factors
- Understand resistivity and state its symbol
- Apply resistivity in the appropriate formulae to obtain resistance of a given conductor in practical applications
- Understand the theory and application of a Wheatstone bridge circuit
- Apply resistivity and the Wheatstone bridge circuit in practical applications

Temp. Coeff. – Apply

Apply the concept of temperature coefficient of resistance to practical applications.

- Understand temperature coefficient of resistance
- Apply temperature coefficient of resistance in formulae associated with practical applications

D Kirchoff's Laws – Describe and apply

Describe the concept of Kirchoff's Laws; apply Kirchoff's laws to analyse simple resistor networks.

- Describe the concept of Kirchoff's laws to determine unknown currents and voltages in d.c. circuits
- Apply Kirchoff's law to d.c. circuits

E Electrostatics – Describe

Describe the concepts of simple electrostatics and capacitance; explain the operation of a capacitor in a dc circuit using a simple constructional model and basic electrostatics.

- Describe an electrostatic field
- Describe a capacitor and draw the standard symbol
- Describe capacitance C and state its symbol and unit

- Describe electric field strength E and state its unit
- Describe electric flux density D and state its unit
- Describe permittivity, distinguishing between εo , εr and ε
- Use calculations involving the physical and electrostatic parameters of a capacitor
- Use calculations involving the energy stored in a capacitor
- Use calculations involving capacitors in a series and/or parallel circuit

RC Circuits – Apply

Apply the behaviour of voltage and current in mixed networks of resistance and capacitance; demonstrate understanding of the relationships between current, voltage and time when a capacitor is charged/discharged in a simple RC circuit.

- Understand the term transient
- Describe the transient behaviour of voltage and current in a charging/discharging capacitor
- Describe the term 'time constant of a circuit'
- Apply 'time constant' formulae to the parameters of a circuit
- Apply growth and decay curves to the parameters of a circuit
- Apply instantaneous current/voltage formulae to an RC circuit

F Faraday's and Lenz' Laws – Describe

Describe the concepts of Faraday's and Lenz' Laws; demonstrate understanding of Faraday's Laws and Lenz's Law.

- Understand how an emf may be induced in a conductor
- Describe the concepts of Faraday's law of electromagnetic induction
- Describe the concepts of Lenz's law of electromagnetic induction

Self and Mutual Inductance – Describe and apply

Describe the concepts of self and mutual inductance and demonstrate an understanding of self and mutual induction; apply the behaviour of voltage and current in mixed networks of resistance and inductance; demonstrate an understanding of inductive DC transients and suppression methods.

- Describe the concepts of self induction
- Describe the concepts of mutual induction

- Apply Fleming's rules to determine relative directions of magnetic field, motion and current/induced emf
- Apply calculations to determine induced emf for a change in flux or change in current
- Describe inductive d.c. transients
- Describe transient suppression methods

G Magnetic circuits – Apply

Apply the applications of magnetic circuits and demonstrate understanding of basic electromagnetism.

- Describe magnetic flux and magnetic flux density and state their units
- Describe magneto motive force and magnetic field strength and state their units
- Describe permeability and distinguish between μo , μr and μ
- Describe B-H curves (and hysteresis loop) for different magnetic materials
- Apply formulae to calculations involving magnetic flux, magnetic flux density, magneto motive force, magnetic field strength and permeability

H Circuit Theorems – Describe and apply

Describe the fundamentals of Thevenin's and Norton's theorems; describe the fundamentals of voltage, current and power in networks; Apply circuit analysis to network analysis of voltage, current and power in d.c. circuits.

- Describe the superposition theorem and apply it to find currents in a d.c. circuit
- Describe Thevenin's theorem and apply it to find an equivalent model for a d.c. circuit
- Describe Norton's theorem and apply it to find an equivalent model for a d.c. circuit
- Apply the three theorems to circuit analysis voltage, current and power in a d.c. networks

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At the end of the process of breaking apart and then recombining the learning/competency outcomes for the two courses, the result produced a set of learning outcomes or learning/teaching guides and a set of assessment or competency outcomes. The learning outcomes overcame the difficulty presented by teachers to the teaching of unit standards that there were few guidelines as to what to teach, yet on the other hand, the assessment or competency outcomes focuses the teacher and student on the expectations from the learning process that are to be assessed for achievement and competency. A further and definitive way of focusing on the learning/assessment outcomes is to mentally precede each statement of outcome with words such as “For Test 1, the student should be able to…” or “By the end of the course the student should be able to…”.

5.2.12 Performance Criteria

The last step in creating the framework of learning outcomes is to specify the performance criteria. Associated with those outcomes that use the word ‘describe’ is that the response must provide a coherent statement, identify characteristics, and is supported by a valid illustration (where applicable), and for those outcomes that use the word ‘apply’ is that the response must demonstrate appropriateness of principles/ rules/ formulae/ data through tests, experiments or problems, valid and logical use of concepts/ rules/ formulae/ data through manipulation, computation or presentation and valid use or interpretation or adaptation of concepts and formulae through behaviour, properties, components or materials.

5.3 CREATION OF THE ASSESSMENT PLAN

5.3.1 Introduction

The assessment plan is developed from the assessment framework and it provides an overview and description of the types of assessment to be developed and used, and how they will be administered, scored, and reported. The plan must fit under the umbrella dictated by the assessment weightings specified in the Dip Tech prescription, i.e. assignments and laboratories (20% of marks), tests (20% of marks) and examination (60% of marks). The structure and emphasis of the laboratory exercises and the assignments are within the management of the learning environment. Tests are open for teacher intervention and the learning environment should also provide experience for students preparing to sit the end of course examination. The examination is established from outside the domain of the teacher.

Where assessment can be planned by the teacher, (i.e. the internal assessment), the unit standard competency requirements are to be incorporated into the assessment. The competency requirement for each assessment group will have to be met, and competency will be equivalent better than 50% of the marks for that group.

The range of formal assessment instruments will be confined to those set by the individual Dip Tech course prescriptions because they are the primary assessment guidelines. Table 5.11 provides a summary of the types of assessment method suitable for each assessment instrument.

Table 5.11

Assessment Methods Associated with Assessment Instrument

Instrument \ **Assessment Method**	Block diagrams	Calculations	Circuit diagrams	Documentation	Flow charts	Practical work	Questioning	Reasoning skills	Report writing skills	Research & Detective work	Revision Questions	Short answer questions
Classroom Exercises	●	●	●		●		●				●	●
Laboratory Exercises	●	●	●	●	●	●		●		●		
Formal Tests	●	●	●		●			●				●
Assignments	●			●				●	●	●		
Examination	●	●	●					●				●

5.3.2 Assessment Criteria – An Overview

Assessment within the confines of the first year core electrical/electronic Dip Tech courses and the Unit Standards that are subsumed by the Dip Tech courses, has to fit within the umbrella specifications of both courses and be guided by documentation provided by the agencies responsible for the delivery and/or maintenance of the programmes or courses. The documentation that was researched for assessment directions and/or guidelines were …

- MYTEC Academic Policy
- MYTEC Assessment Policy
- Dip Tech Endorsement Documentation.
- Individual Dip Tech course prescriptions.
- Material from ETITO, who has the responsibility for establishing the NDE, registering the individual unit standards on the qualifications framework, maintaining the content of the unit standards and establishing moderation of the training providers.
- Unit Standard learning outcomes.
- The requirements and/or guidelines produced by the NZQA who maintains the NQF.
- Other documentation produced by NZQA and associated training agencies for the guidance of assessing unit standard learning outcomes.

In addition to these documents were the data of operative conditions placed on the teacher through the consortium of departments of various technical institutes who in teaching the NDE, made decisions regarding how the NDE was to be assessed. This 'directive' was based primarily on the arguments that there was a need to set an examination for the NDE as a method of assessing student competency and as a method of moderating to a uniform teaching/learning standard.

5.3.3 Summary of Assessment Considerations

The assessment directions and/or guidelines for each of the Dip Tech courses should provide students with the opportunity to meet the competency-based assessment criteria for the equivalent unit standards as well as meeting the obligations of the achievement-based assessment criteria for the Dip Tech courses.

The assessment objectives of the dual assessment framework should be such that …

- Assessment for the achievement based MYTEC Dip Tech Electrotechnology programme must meet the criteria set out in the institution and curriculum documentation and give a fair and ample opportunity for students to accumulate sufficient weighted marks to generate a pass grade. An overall mark of 50% or higher represents a pass.

- Assessment for the NDE programme is competency-based assessment and students must be given fair and ample opportunity to demonstrate that they can attain a given level of competence in each of the specified elements and their associated range statements.

- In the simultaneous dual assessment scenario of this study it should however be possible to combine the competency assessment requirements for the Unit Standard with that of achievement for the Dip Tech course so that a 'mark' better than approximately 50% equivalent under an achievement approach, would also be deemed to have met the competency requirement for that outcome.

- Examinations are not necessary for the NDE Unit Standard assessment. The use of an examination is primarily a requirement of the Dip Tech programme. The use of an examination for the NDE should not be to use a 'pass' mark in the overall examination to award a blanket 'pass' for the range of competencies. The use of an examination should be seen from the NDE perspective as an opportunity for a further resit for any competencies that had not been completed during the course. The examination would need to be set in a way that each competency in the unit standard is clearly identified in the examination so it can be individually tested for competency, while at the same time generate marks for the Dip Tech course.

- A student receiving an overall final “C Pass” or better grade for the Dip Tech course cannot automatically be granted a “Pass” for the Unit Standard competency criteria: i.e. 50% or better for the Dip Tech course does not mean that a student has met all the competency requirements of the Unit Standard(s).

- There is no clearly documented indication of what would be considered competency for an element in a unit standard when traditional tests are used to determine the level of skill in a theory application. For example, 50% in an achievement-based assessment would constitute a pass, but does 50% in a similar test mean a ‘pass’ in a competency. Other courses use different minimum percent marks for competency (e.g., 60%). This judgement is left to the teacher/assessor.

- A student meeting all the Unit Standard competency requirements may not by this alone be deemed to also have achieved a minimum of a “C Pass” or better for the Dip Tech course. Institute requirements prevent a person credited with a Unit Standard from gaining recognition for a Dip Tech course unless that student enrols and meets the achievement grade requirements. There is no indication that suggests that competency in all or part of assessment for a unit standard has reached a ‘pass’ level for all or any of the Dip Tech assessment.

- Because students face an examination that is weighted to 60% of the final achievement mark, they expect test questions to be written in a similar format to the examination questions so they may experience examination conditions before the event itself. The facilitation of this would be considered as adhering to the principles of fair assessment.

- It is expected that learning will occur outside the classroom (i.e. the 75 hour requirement for both the total tuition hours and the self-directed learning hours)

- The teaching/learning/assessment material designed for a core Dip Tech course, each of which subsumes one and a part Unit Standard, is to be prepared so that learning and therefore the assessment for the four Dip Tech electrical/electronic courses would also provide satisfactory assessment opportunities for the five Unit Standards subsumed within the Dip Tech courses.

5.3.4 Assessment Criteria from Dip Tech Documents

The Dip Tech course documentation sets out the assessment criteria for each course. The example below is standard over many of the courses and tends to follow what could be described the traditional approach to assessment, i.e. 40% of the marks assigned to internal assessment held during the course and associated with many hours of work, and 60% of the marks associated with a 2 hour examination at the end of the course. This then became one of the main restrictive inputs into the learning environment.

Assessment

Mixed Mode

Criteria:	Achievement Based	Weighting
Assignments and Laboratories		20%
Tests		20%
Examination		60%
TOTAL		100%

Note: Assignments and laboratories are used as appropriate.

Criteria: Competency

Students must meet the competency criteria of the unit standards as detailed in the competency assessment guide.

Figure 5.4. Assessment Criteria, extracted from the Dip Tech, Direct Current course documentation

This section of the documentation clearly establishes the responsibility to provide assessment so that students have the opportunity to meet the competency criteria of the unit standards at the same time.

5.3.5 Combining the Assessment

The external influences of course prescriptions, unit standard competency requirements and the external examination made it difficult to formulate a satisfactory assessment scoring model that incorporates the desired concepts of the assessment framework; i.e. a student meeting competency requirements for the unit standard could also be deemed to have gained at least 50% of the marks for the Dip Tech course, except that the institutional policies forbid it. There was a need to make some experiential and subjective decisions of how to build a final model that is a compromise, given the constraining influences.

a. The final scoring of the achievement-based Dip Tech will be the aggregation of marks in accordance with the course requirements. There is no difficulty with this.

b. An award of a Pass for the Unit Standard(s) will be the meeting of the competency requirements of the internal assessed practical exercises, assignments and tests and a minimum of 50% pass in the examination. (This model will fit in with the requirement that a pass in the unit standards could constitute an equivalent "C" pass for the Dip Tech course and is based on the past NZCE requisite that a 'pass' in internal course work and a 'pass' in the external examination are required to achieve a pass for that course). Each outcome that is specified in the element (either directly or indirectly within a range statement) must be subjected to assessment that will determine whether competency has been attained.

This approach means that 'internal' assessment can accommodate both diploma criteria provided the assessment instrument clearly shows each learning outcome and the measure of competency.

5.3.6 Internal Assessment

Practical Exercises (e.g., laboratory experiments) will…

1. In general, serve to meet the assessment objectives that require an 'apply' level of competency and provide a practical learning/assessment base.
2. Be organised in a self-paced mode with the ability to complete circuit investigations with actual physical equipment, computer simulation software, or a mixture of both.
3. Require students to resubmit any work that does not meet the required competency standard. When the resubmitted work is granted a competency pass, 50% of the marks will be allocated for that section.
4. Require students to complete an exercise before commencing the next exercise.

Written Assignments will…

1. In general, serve to meet a selection of assessment objectives in a 'real-world' scenario.
2. Require students to complete a series of tasks against a series of deadlines. This is to train students to work systematically towards the completion date, as well as provide an opportunity to lessen the marking workload as each section can be marked as it is finished.
3. Require students to resubmit any work that does not meet the required competency standard. When the resubmitted work is granted a competency pass, 50% of the marks will be allocated for that section.

Tests will…

1. In general, serve to meet the assessment objectives that require a "describe" level of competency as well as those that require an "apply" level of

competency where that application can be achieved with a theoretical approach.

2. Contain a series of questions to target the competency assessment criteria. This will enable the minimum bench line criteria to be set as well as support the need for achievement-based assessment.
3. Require students to resubmit any work that does not meet the required competency standard. If the resubmitted work does meet the competency requirement, the original pre-submission mark will be allocated for that section.

5.3.7 External Assessment

The consortium, of which MYTEC has been a member, currently sets the examination. There are several factors which impact on to the overall learning/assessment environment.

1. One of the stated reasons for using a common or shared examination between consortium members is that it will provide a benchmark for moderation purposes.
2. The only teaching/assessment link between the members of the consortium is the common NDE Unit Standards. Many examinations scripts are supplied with the Unit Standard number yet the examination format, types of question predominately matches the past NZCE equivalent course prescription. Marks per question of this examination are substantially the same as the previous NZCE courses. Other institutes offer their own diploma qualification in a way that is similar to the MYTEC diploma.
3. There is little or any apparent provision to individually 'target' competency criteria from the Unit Standard learning outcome perspective, making it very difficult to relate students' scoring abilities to the competency requirements.
4. Because the Unit Standards have replaced the equivalent NZCE courses, the Dip Tech courses subsume one and a part Unit Standard and the examination is

presented as being for a particular Unit Standard. It was then necessary to modify the examination by taking 20% of marks off each question (i.e. the theory content area of the past NZCE prescription) and adding more questions to cover the Dip Tech course content. This method adhered to the theory content weighting of the past NZCE course prescriptions (even though the Dip Tech course prescription does not provide weightings for learning outcomes).

5. It should be possible to compose examinations that are directed towards the Unit Standard competency requirements while at the same time allow for achievement-based assessment. This supposition is supported by the examples of Mathematics and Science examinations for both level 1 and 2 of the NCEA, which provide for the grading of achievement.

5.3.8 Assessment Principles

The NZQA has produced two documents that are useful in the process of developing assessment instruments. *To your marks! Advice to teachers and tutors on setting and marking assessments* (New Zealand Qualifications Authority, 1997) gives guidance for assessment that produces marks (category "Achievement-Based Assessment: NZQA") and *Best practice assessment principles for the assessment of unit standards* (New Zealand Qualifications Authority, 2005) that gives guidance for assessment of Unit Standards. Both these documents are summarised into categories in Chapter 4.

For the achievement-based assessment, a good test or examination would:

- Be a fair and valid assessment of students' knowledge, understanding and abilities in relation to the expected learning outcomes of the course prescription or course statement.
- Give students ample opportunity to show what they know and can do rather than reveal what they do not know or cannot do.
- Adhere to any requirements specified in the course prescription or course statement.
- Be clear, ambiguous and error free.

- Be well balanced in terms of time allocation and mark allocation.
- Be accompanied by a good marking schedule.

For the competency-based assessment, best practice in assessment will occur when the assessor focuses on elements, and gives due consideration to all performance criteria within the unit standard(s). In order to achieve this, the assessor should consider the following…

- Unit standards are statements of what a person knows and/or can do, expressed as outcomes.
- The element(s) identify the outcomes against which the candidate is assessed.
- Performance criteria do not express outcomes. They indicate the minimum evidence to consider when making a judgement as to whether the candidate has achieved the outcomes of the element and, therefore, the standard. Sufficiency of evidence should be described in the assessment schedule.
- Assessment(s), and the basis for making assessment decisions, must be designed to be consistent with the unit standard.
- Assessment(s) should be designed to focus on the wholeness of performance against the outcomes identified in the elements. Assessment(s) designed for individual performance criteria may lead to over-assessment.

5.4 DETERMINATION OF ASSESSMENT RESOURCES

The determination of assessment resources was a necessary exercise to ensure the type of assessment envisaged in the assessment plan could be performed. If resources are insufficient, adjustments will be needed in the assessment plan. In the scenario outlined in this study, assessment resources consisted of paper resources created by the tutor and examiner, and those resources required for 'laboratory' and assignment exercises. Provision of any equipment other than that which was currently available in laboratories cannot be considered. Computers and the required software for completion of assignments and for computer simulation of electrical/electronic circuits was available to students at all times. The need for resources was therefore not likely to be influenced by what is required for assessment, but rather that the assessment was planned around the available resources.

5.5 DEVELOPMENT OF A MARKING SYSTEM

5.5.1 Development of a marking system

Well-articulated scoring criteria will promote assessment that is easily administered, scored and interpreted by teachers, and generate accurate, meaningful information. It will facilitate interpretation of assessment results and self-assessment that can be part of the provision of formative feedback to the students to assist with remedial assistance, thus promoting fairness in assessment.

Examinations for achievement-based assessment "is clear, ambiguous and error free, is well balanced in terms of time allocation and mark allocation, is accompanied by a good marking schedule (New Zealand Qualifications Authority, 1997, p. 6). A good marking schedule will reflect the expected learning outcomes of the course prescription or course statement, give the main points required in students' answers and acceptable alternatives, and show any calculations that are required. It will also clearly show how marks are allocated within each question and what students need to do in order to earn these marks, assist the marker in making judgements on whether or not students' answers will be awarded the specified marks, and it should be prepared at the same time as the test or examination is being set.

While a good marking schedule is considered essential, there are some major disadvantages. There is a need to construct a different marking schedule for every assessment. It takes time to rationalise the number of full or part marks that an individual answer can justifiably be given. Students are quick to discover anomalies between their marks and someone else's mark, even to the point of arguing over a ½ mark difference in a test out of 48 marks. A difference in ½ mark when seen in perspective with the final mark after it has been weighted to being one of three tests that make up 20% of the final mark, although insignificant, becomes important to a student. A mark should be accompanied with a statement about the student's response in order for it to have meaningful feedback. It is difficult to apply a number to a test for competency.

When considering how to develop a standards-based marking system, educators need to ask a series of questions. Are the standards written with a focus on what the learner will do? Are they measurable? Do they provide equal access to educational opportunities for all students? Are assessments purposefully aligned with standards and instruction? Do teachers have to report on how well each student progresses according to each standard (Colby, 1999)? Alternatives to marking schedules are criteria assessment grids as discussed in O'Donovan, Price, and Rust, (2001). Another alternative is the use of marking or scoring rubrics. In this study the decision was made to investigate the use of a rubric to mark the assessment against achievement and competency criteria.

Performance rubrics have two common features, a list of criteria and graduations of quality. They provide a means to assess postsecondary academic skills on the basis of such a scale that presents a continuum of performance levels, defined in terms of selected criteria, towards to full attainment or development of the targeted skills. They provide a framework that helps assessors to be consistent, focuses the attention of assessor and the assessed on important outcomes, and establish benchmarks for documenting progress. Rubrics provide a grid of criteria necessary to improve students' work and increase their knowledge and guide students to build on existing knowledge. The well-defined performance levels allow students to reflect on and reveal problems that will be more informative than vague levels of quality or a simple numeric mark. In this way, they help to improve students' end products and therefore increase learning. The use of rubrics however does not however sit comfortably within the traditional concept of a 'marking schedule' and the allocation of marks, so part of this study was to investigate the use of rubrics, the development of a rubric for use with both the achievement-based and the competency-based assessment, the acceptance of the rubric by the students and the difference it would make in the marking time of assessment material.

5.5.2 Developing Scoring Rubrics

When a scoring rubric is to be developed, the performance criteria and the attributes that constitute the qualitative degrees of performance should be clearly described and stated consistently from level to level. When the task, criteria, and attributes are clear for students, a rubric can broaden the possibilities for the rubric's use. It could be used to assess the same skills in either a formative or a summative context with respective instructions. To complete the marking rubric, a title, a statement of purpose, and instructions for using the rubric should also be added (Tierney & Marielle, 2004).

Scoring rubrics may be used to evaluate students' responses to the two frequently discussed performance assessments: analytic and holistic. Analytic scoring rubrics divide a performance into separate parts and each is evaluated using a separate scale. Holistic scoring rubrics use a single scale to evaluate the larger process where all the parts that make-up the task are evaluated in combination (Moskal, 2003). The recommendations for developing scoring rubrics that follow are appropriate to both analytic and holistic scoring rubrics (Moskal, 2003).

Table 5.12

Recommendations for Developing Scoring Rubrics

1. The criteria set out in a scoring rubric should be clearly associated with the stated goals and objectives and the requirements of the task.
2. The criteria set out in scoring rubrics should be expressed in terms of observable behaviours or product characteristics.
3. Scoring rubrics should be written in specific and clear language that the students understand.
4. The number of levels used in the scoring rubric should make sense and should clearly reflect the value of the activity.
5. The separation between score levels should be clear and reflect clear differences between the achievement levels.
6. The statement of the criteria should be fair and free from bias.

After much reading of the available literature, a scoring rubric was developed that could be used by both teacher and students in the marking of assessments. A handout was produced which introduced the rubric concept, described the scale length and the major attributes of the scale, the different scales, using the rubric, the holistic scale and individual scales for the individual parts of assessment. The complete document was printed on A3 paper as a double-sided A4 bifold handout and made available to students. The summary of the individual rubrics was printed double-sided on coloured, A4 light card for students' day-to-day use and it was this document that became an essential part of the working model. Parts of the main brochure are discussed below and the whole of the brochure is reproduced in the appendix.

On the first page of the brochure, an introduction set out the need for scoring assessment and how a rubric can be used to facilitate that process.

Diploma Marking Rubric / Scoring Schedule

Introduction

The following rubric or schedule has been produced to encourage the learning process, to provide a focus for documenting knowledge and to assist the performance assessment process.

Both achievement-based assessment and competency-based assessment are standard or criterion referenced, performance assessment. In other words, if you meet or perform satisfactorily against the standard or criteria, then you can be described as either having achieved or are competent against that performance criteria. Scoring a performance assessment usually involves making some subjective judgments about the quality of a student's performance. If the student does not know what the scoring guidelines are, or even if the scorer is hazy about such guidelines, the reliability of the assessment becomes questionable.

A rubric establishes a set of scoring guidelines to provide a way to make judgments fair and sound by setting out a uniform set of precisely defined criteria or guidelines used to judge student work. It will define levels of excellence and therefore help students achieve it, help students evaluate or assess their own and other student's work, communicate goals and help raters to be accurate, unbiased and consistent in scoring.

Figure 5.5. Introduction paragraph to the student's brochure

The rest of the first page was devoted to an introduction to the scale length and an explanation of how the scale is to be used to facilitate the marking or grading of assessment and providing both formative feedback and summative scoring.

Scale Length

The length of the scale is the number of grades from a no response to a perfect response. In keeping with the MYTEC assessment policy achievement grades, this rubric has been developed with five categories corresponding to the possible final grades, with two extra categories – unanswered and a resit pass. Internally assessed responses not achieving a "C" or better will require a "resit" of that element of work.

The scale length of this rubric is 6.

A.	**Exceptional** (a response with no flaws)
B.	**Proficient** (a response with a minor flaw)
C.	**Acceptable** (a response with a few flaws)
D.	**Substandard** (a response with serious flaws)
E.	**Unsatisfactory** (a response that fails to progress)
F.	**Unanswered** (no response)
R.	**Resit Pass** (graded as Marginal after resit)

A grade of A, B, or C is considered as having demonstrated competence.

A grade of D, E, or F is considered as not yet demonstrated competence.

Figure 5.6. Description of scale length and criteria for each scale

The next paragraph further outlined the scale descriptor as being a focus for the assessment achievement and suggested to the students that as there were many different aspects associated with their assessment, different scale descriptors would be provided for each.

Scales

A scale is essentially a topic or focus for the assessment. The following topics have been identified as being those that are likely to be encountered while undertaking the various types of assessment. Topics are application, calculations/units, circuit diagram, communication, data record, elements of problem, graph/timing diagram/flowchart, list of equipment, mathematical/written reasoning, understanding, use of equipment, written description/explanation.

Figure 5.7. Further explanation of scale descriptors

I felt it was important to include a section on the wider concept of using the rubric and so a section was included on using the rubric in a holistic and in an individual manner.

Using the Rubric

The grading concept contained within the rubric may be used or considered in two ways: holistically or individually.

> **Holistically, as in a short exercise…** (holistic – adjective, chiefly "Philosophy characterized by understanding the parts of something to be intimately interconnected and explicable only by reference to the whole").
>
> **Individually, as in a laboratory exercise…** i.e. a laboratory exercise may involve circuit diagram, data record, graph and use of equipment.

Figure 5.8. Using the rubric holistically or individually

The last part of the main section of the brochure was turned over to a fuller explanation of the use of the scales from a holistic viewpoint.

Holistic Scale

A Exceptional. Gives a complete (but not necessarily perfect) response and the student demonstrates an in-depth understanding of the task.

B Proficient. Gives a fairly complete response and the student demonstrating a good understanding of the task.

C Acceptable. Completes the task satisfactorily, and demonstrates an understanding of the major concepts even though the student overlooks or misunderstands less important ideas or details.

D Substandard. Begins the task appropriately, but either fails to complete or omits a significant part of the task, makes major errors, may misuse or fail to use appropriate terms or the response may reflect an inappropriate strategy for solving the task; i.e. the student demonstrates that there are gaps in his/her conceptual understanding..

E Unsatisfactory. Begins, but with an inappropriate response that suggests either no understanding of the task, the inability to attempt the task even when parts of the task are copied or a failure to indicate which information is appropriate to the task i.e. the answer may be totally incorrect or irrelevant.

F Unanswered.

Figure 5.9. Expanded descriptors for the holistic scales

The other two pages of the A4 sized brochure were used to outline the scale descriptors for a number of individual assessment requirements. A list of 12 sets of scales were given and included the use for Application, Calculation/units, Circuit diagram or drawing, Communication, Data record, Elements of problem, Graph/timing diagram/flowchart, List of equipment, Mathematical/written reasoning, Understanding, Use of equipment and Written description/explanation. Prior to the start of the semester and the trial of the assessment model, this was considered a suitable range of topics. Two are given here as examples.

Graph/timing diagram/flowchart

A – are neat, accurate, labelled, keyed, and generated with software where possible.
B – are accurate with a minor omission and generated with software where possible
C – are correct and appropriate with a few omissions and may be hand drawn where generation with software is possible.
D – accurate but incomplete.
E – inaccurate and incomplete.

List of equipment

A – is neat, accurate and fully identifies (where possible) each item of equipment.
B – is neat, and accurate but does fully identify (where possible) each item of equipment.
C – accurate but is not neat and tidy and may not fully identify (where possible) each item of equipment.
D – tidy but incomplete and may not fully identify (where possible) each item of equipment.
E – incomplete and items of equipment cannot be identified.

Figure 5.10. Two examples of individual scale descriptors

5.5.3 Use of the Marking Rubric

Although the use of the marking rubric is further discussed in the next chapter, it is worthy to say that from the teacher's marking perspective it was a success. By determining the expected quality of responses from students in terms of grades, it was an easy matter to determine whether competency was met. This is further discussed in the next two sections of this chapter.

I found no clear documentation for the use of a marking rubric that would easily convert a grade into marks so it became an experimental exercise to determine the means to achieve this. However the academic regulations do specify the relationship between marks and the overall grade awarded at the completion of a course in the form of a table.

Table 5.13

Relationship Between Marks and Grades from the Academic Regulations

Mark (%)	Grade	Alternatives	Result	Explanation
90–100	)	A++	)	
85–89	) A	A+	) Pass	Distinction
80–84	)	A	)	
75–79	)	A–	)	
70–74	)	B+	)	
65–69	) B	B	) Pass	Credit
60–64	)	B–	)	
55–59	) C	C+	) Pass	Pass
50–54	)	C	)	
40–49	D	D	) Fail	Fail
0–39	E	E	)	

Because the Dip Tech courses use the grade level and not the alternative grade, the marks and grade can be summarised as follows.

Table 5.14

Relationships Between Marks and Grades for Dip Tech Courses

Mark (%)	Grade	Explanation
75–100	A	Distinction
60–74	B	Credit
50–59	C	Pass
40–49	D	Fail
0–39	E	Fail

Or alternatively, the following format presents the range of grades and marks on a continuum.

Table 5.15

Alternative Relationships Between Marks and Grades for Dip Tech Courses

Grade	E	D	C	B	A
Mark	0 - 39	40 - 49	50 - 59	60 – 74	75 - 100

Reasoning suggested that if a range of marks can be represented by a grade, then the grade in itself can only indicate that the original mark is somewhere in the range that the grade represents. Likewise if a mark could be generated from a rubric scale (or grade), then any variation from what the mark would have been if a marking schedule were used would in turn have little if any variation in the final grade. To help to determine suitable factors for this theory, a spreadsheet was used to experiment with a ‘mid range’ figure. The ranges are based on those from the academic regulations.

After some experimentation that consisted of adjusting the weighting factor and marking of sample questions, it was decided that a rubric grade could be represented by a mark if the full value of the piece of assessment was multiplied by a weighting factor. The weighting factors were taken from the spreadsheet after the experimentation had been completed. A rubric scale of A has a weighting factor of 0.9, B a factor of 0.7, C a factor of 0.56, D a factor of 0.45 and E a factor of 0.2. If no response is given to the question, then no marks are awarded. The use of the rubric to determine a letter scale for each assessment item was followed by multiplying the letter scale by the weighting factor. This greatly assisted the process of reaching a satisfactory achievement mark while at the same time facilitation of determining whether competency had been reached. There was clear indication from the students that after the short introductory period, they appreciated the ease with which it facilitated self- and peer-assessment, as well as the more informative assessment feedback it provided following a teacher marked test or assignment.

Scoring Rubric - For Laboratory Exercises, Assignments and Tests

Unanswered (F) · Unsatisfactory (E) · Substandard (D) · Acceptable (C) · Proficient (B) · Exceptional (A)

	<---------- Not Yet Competent ---------->						*<------------------------------- Competent ------------------------------->*								
Grade Boundaries	<-------	E	------->	<-------	D	------->	<-------	C	------->	<-------	B	------->	<-------	A	------->
'Out of' marks	**0%**	**20%**	**39%**	**40%**	**45%**	**49%**	**50%**	**56%**	**59%**	**60%**	**70%**	**74%**	**75%**	**90%**	**100%**
1.0	0.00	**0.2**	0.39	0.40	**0.5**	0.49	0.50	**0.6**	0.59	0.60	**0.7**	0.74	0.75	**0.9**	1.00
1.5	0.00	**0.3**	0.59	0.60	**0.7**	0.74	0.75	**0.9**	0.89	0.90	**1.1**	1.11	1.13	**1.4**	1.50
2.0	0.00	**0.4**	0.78	0.80	**0.9**	0.98	1.00	**1.2**	1.18	1.20	**1.4**	1.48	1.50	**1.8**	2.00
2.5	0.00	**0.5**	0.98	1.00	**1.2**	1.23	1.25	**1.4**	1.48	1.50	**1.8**	1.85	1.88	**2.3**	2.50
3.0	0.00	**0.6**	1.17	1.20	**1.4**	1.47	1.50	**1.7**	1.77	1.80	**2.1**	2.22	2.25	**2.7**	3.00
3.5	0.00	**0.7**	1.37	1.40	**1.6**	1.72	1.75	**2.0**	2.07	2.10	**2.5**	2.59	2.63	**3.2**	3.50
4.0	0.00	**0.8**	1.56	1.60	**1.8**	1.96	2.00	**2.3**	2.36	2.40	**2.8**	2.96	3.00	**3.6**	4.00
4.5	0.00	**0.9**	1.76	1.80	**2.1**	2.21	2.25	**2.6**	2.66	2.70	**3.2**	3.33	3.38	**4.1**	4.50
5.0	0.00	**1.0**	1.95	2.00	**2.3**	2.45	2.50	**2.8**	2.95	3.00	**3.5**	3.70	3.75	**4.5**	5.00
5.5	0.00	**1.1**	2.15	2.20	**2.5**	2.70	2.75	**3.1**	3.25	3.30	**3.9**	4.07	4.13	**5.0**	5.50
6.0	0.00	**1.2**	2.34	2.40	**2.7**	2.94	3.00	**3.4**	3.54	3.60	**4.2**	4.44	4.50	**5.4**	6.00
6.5	0.00	**1.3**	2.54	2.60	**3.0**	3.19	3.25	**3.7**	3.84	3.90	**4.6**	4.81	4.88	**5.9**	6.50
7.0	0.00	**1.4**	2.73	2.80	**3.2**	3.43	3.50	**4.0**	4.13	4.20	**4.9**	5.18	5.25	**6.3**	7.00
7.5	0.00	**1.5**	2.93	3.00	**3.4**	3.68	3.75	**4.2**	4.43	4.50	**5.3**	5.55	5.63	**6.8**	7.50
8.0	0.00	**1.6**	3.12	3.20	**3.6**	3.92	4.00	**4.5**	4.72	4.80	**5.6**	5.92	6.00	**7.2**	8.00
8.5	0.00	**1.7**	3.32	3.40	**3.9**	4.17	4.25	**4.8**	5.02	5.10	**6.0**	6.29	6.38	**7.7**	8.50
9.0	0.00	**1.8**	3.51	3.60	**4.1**	4.41	4.50	**5.1**	5.31	5.40	**6.3**	6.66	6.75	**8.1**	9.00
9.5	0.00	**1.9**	3.71	3.80	**4.3**	4.66	4.75	**5.4**	5.61	5.70	**6.7**	7.03	7.13	**8.6**	9.50
10.0	0.00	**2.0**	3.90	4.00	**4.5**	4.90	5.00	**5.6**	5.90	6.00	**7.0**	7.40	7.50	**9.0**	10.00

Figure 5.11. Spreadsheet used to examine possible relationships between a rubric scale (grade) and the mark that could be generated

The A+ grade was requested by the students and as there was no reason not to accept their request, a further scale was added after a short trial period to allow for those responses to questions such as calculations in which there is no question as to the 100% value of the answer. The full scale then gave a total of 7 steps, although A through E were the most commonly used and referred to.

Table 5.16

Weighting Factors to Convert a Rubric Scale to an Achievement Mark

Rubric Scale	Weighting Factor	Explanation
A+	1.0	Perfect
A	0.9	Exceptional (a response with no flaws)
B	0.7	Proficient (a response with a minor flaw)
C	0.56	Acceptable (a response with a few flaws)
D	0.45	Substandard (a response with serious flaws)
E	0.2	Unsatisfactory (a response that fails to progress)
F	0.0	Unanswered (no response)

A scoring register was placed at the end of each assessment item to facilitate the recording of the awarded scale. A careful scrutiny of the answer quickly revealed the appropriate response and the question item was marked by circling the scale.

(6 Marks) *E* *D* *C* *B* *A* *A+*

Figure 5.12. Sample of the scoring register

5.5.4 The Criteria for Competency

Of specific interest in this section is to specify criteria that would determine whether competency had been attained. This criteria is required for laboratory exercises, written assignments and for tests. Although the examination is not within the influence of the teacher, it was considered that if the marking of competency for a section of a test that uses examination type questions could be demonstrated, an examination could also be produced to meet the same competency determination criteria.

Responses to both laboratory exercises and written assignments were deemed to have met competency when each section achieved a "C" grade or better. For any section of work had to be resubmitted and if the competency level had been achieved, then a "R" (for Resit) was given. As shown later, achievement marks were derived from these grades.

Tests were treated differently in that for most sections, more than one question was presented to the student and competency was determined on the basis of a composite result in that section. For example in the DC Circuits course, test 1, one section has competency set as "Q2 and Q3, Proficient answer for ONE question demonstrating an understanding of the properties (minimum requirement – B), PLUS, Acceptable answer for other question (minimum requirement – C). The following table sets out the competency criteria for the DC Circuit course, test 1, and a similar table for each test for each course was prepared.

Table 5.17

Competency Requirements for Test 1 of Direct Current Course

Section A Electrical Concepts, Ohm's Law (6 marks)

Topic	Unit Standard 16964 Assessment Criteria	Minimum Competency Criteria
A	16964.1.a Describe the definitions of voltage, current, power.	Q1 Acceptable answer demonstrating an understanding of the meanings of voltage, current and power. (minimum requirement – C)
	16964.1.b Describe the properties of resistance in direct current (d.c.) circuits.	Q2 & Q3 Proficient answer for ONE question demonstrating an understanding of the properties. (minimum requirement – B) PLUS Acceptable answer for other question. (minimum requirement – C)

Section B Series / Parallel Circuits (18 marks)

Topic	Unit Standard 16964 Assessment Criteria	Minimum Competency Criteria
B	16964.2.a Apply the analysis of voltage, current and power in d.c. circuits.	Q4 & Q5 Proficient answer for ONE question demonstrating an understanding of analysing a d.c. circuit. (minimum requirement – B) PLUS Acceptable answer for other question. (minimum requirement – C)
	16964.2.d Apply the applications of voltage dividers.	Q6, Q7 & Q8 Proficient answer for ONE question demonstrating an understanding of analysing a d.c. circuit. (minimum requirement – B) PLUS Acceptable answer for other question. (minimum requirement – C) *An acceptable attempt at Q8 may be substituted for one of the questions*

Section C Voltage Dividers & Resistivity (18 marks)

Topic	Unit Standard 16964 Assessment Criteria	Minimum Competency Criteria
C	16964.2.e Apply the applications of resistivity.	Q9, Q10 & Q11 Proficient answer for ONE question demonstrating an understanding of analysing a d.c. circuit. (minimum requirement – B) PLUS Acceptable answer for other question. (minimum requirement – C) Q12 provides opportunity to demonstrate ability to apply calculations to Temperature Coefficient of Resistance.

Section D Kirchoff's Laws (6 marks)

Topic	Unit Standard 16964 Assessment Criteria	Minimum Competency Criteria
D	16964.1.c Describe the concept of Kirchoff's Laws.	Q13 Acceptable answer required to demonstrate an understanding the application of Kirchoff's Laws. (minimum requirement – C)

5.5.5 Marking an Assessment for Achievement and Competency

When the marking of an assessment was complete, the assessment paper was scanned for each scale at a time and the number of marks for each letter in turn was added and entered into a register placed at the beginning of the paper. As an example, an item marked with a "B" and worth 6 marks, would have resulted in 6 B's. After all the scale letters had been counted, the register quickly allowed conversion into marks and the ability to determine whether competency had met the required standard. Competency was indicated for a pass by circling the 'No', indicating that a resit was not required. In other words, a circle around a 'YES' indicated that a resit was required because the competency standard had not been reached.

Summary of Assessment Scoring

Section / Part		*Number of individual grades*						*Resit Required*
		E	***D***	***C***	***B***	***A***	***A+***	
Section A	Part 1				4			*Yes / **No***
Section A	Part 2			3		3		*Yes / **No***
Section B	Part 1			6				***Yes*** */ No*
Section B	Part 2				3	3		*Yes / **No***
Section C	Part 1			6				***Yes*** */ No*
Section D	Part 1				5			*Yes / **No***
		× *0.20*	× *0.45*	× *0.56*	× *0.70*	× *0.90*	× *1.00*	*Total Score*
Weighted score				8.4	8.4	5.4		22.2

Figure 5.13. Example of the scoring register for a test together with sample marking

The example clearly shows the achievement marks for the assessment as a whole and the necessity to resit section B part 1 and section C part 1 in order to attain competency. The criteria for written assignments were similar to that for a test in that the process required the assignment to be handed in to be marked, and then if the competency requirement had not been met, the assignment would be handed back for re-submission. Laboratory exercises were similar but different in that students were expected to self and peer grade each exercise as they were completed, then I would check these marks. Students could not bring an exercise to me for checking if between them a section had not met a "C" which was the competency requirement. If I disputed their grade for a section, they were required to improve their responses and submit for rechecking. The students quickly learnt the procedure and for laboratory exercises and for the assignments, very little re-submission was necessary.

5.6 PRODUCTION OF THE ASSESSMENT BLUEPRINT

5.6.1 Introduction to the assessment blueprint

The blueprint will describe the characteristics of an adequate assessment for each content area of the assessment framework as well as the characteristics of an adequate assessment for each student outcome. Once completed, this should guide the development of the assessments that are needed given the resources available (Roeber, 1996). These characteristics should provide information on the outcomes for each piece of assessment, and how these outcomes will be met. Because the style, content and structure of the examination is external to the learning/assessment environment, assessment blueprints will apply only to internal assessment.

Teachers need for to know how to devise tests so they will become a dynamic tool in the hands of teachers, and of benefit to students (Popham, 1998). Assessment tests should be designed to provide teachers with a tool to clarify and enhance the instructional content of their lessons. To assist the process of avoiding some of the misuses of tests, Suskie (2000), suggests the following steps.

Table 5.18

Suggested Steps to Avoid the Misuse of Tests

1. Have clearly stated learning outcomes.
2. Match your assessment to what you teach and vice versa.
3. Use many different measures and many different kinds of measures.
4. Help students learn how to do the assessment task.
5. Engage and encourage your students.
6. Interpret assessment results appropriately.
7. Evaluate the outcomes of your assessments.

Production of the assessment blueprint should outline the characteristics of the chosen assessment. These characteristics should provide information on the outcomes for each piece of assessment, and how these outcomes will be met. In each area of the internal assessment, a concession to increase marks to a maximum of 50% was made to encourage students though the formative nature of the resit process yet at the same time limit the likelihood of a student choosing to 'fail' on the first attempt in order to get a good mark on the second attempt. Any work that does not meet the required competency standard on the first attempt is to be resubmitted. When the resubmitted work is granted a competency pass, marks will remain the same or be increased to a maximum of 50% of the marks allocated for that section.

An assessment matrix was compiled for each course to demonstrate where each learning topic was to be assessed. In general, each topic was subjected to a written test, and for a 'practical' laboratory exercise or assignment.

Topic		Laboratory Exercise												Assign-ment			Test		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	1	2	3
A	Basic Concepts	✓															✓		
B	D.C. Circuits		✓	✓	✓												✓		
C	Resistivity/ Temp. Coeff.					✓	✓										✓		
D	Kirchoff's Laws							✓									✓		
E	Electrostatics/ RC Circuits								✓	✓				✓				✓	
F	Faraday's and Lenz' Laws										✓							✓	
G	Magnetic Circuits														✓			✓	
H	Circuit Theorems											✓	✓						✓

Figure 5.14. Example of an assessment matrix - DC Circuits course

5.6.2 Summary of Criteria for Assessments

Practical Exercises

1. These are to be organised in a self-paced mode with the provision that students can analyse circuits with either physical equipment, computer simulation software or a mixture of both.
2. Students will be required to complete and achieve competency for a minimum number of set exercises.
3. Each exercise must be completed and assessed before commencing any practical work for the next exercise.
4. Students will be encouraged to undertake preliminary investigation and exercise development outside of timetabled laboratory periods.

Written Assignments

1. Students will be required to complete a series of tasks against a series of deadlines. This is to train students to work systematically towards the completion date, as well as provide an opportunity to spread the marking workload as each section can be marked as it is finished.
2. Assignments are to document an investigation based on one of the 'apply' assessment criteria. This can take the form of a mini project that could develop basic principles into a functioning circuit to meet a specified outcome.
3. Where possible, the research and writing of the assignment is to be done in conjunction with the content of the communication skills course

Tests

1. Questions are to be designed so that each set of questions targets competency assessment criteria. This will provide the minimum bench line criteria as well as support the need for achievement-based assessment. Examples of this concept can be found in the examinations for Physics and Mathematics of the NCEA.
2. Any student who does not meet the competency requirements for a test or section of a test is to be offered one resit. If the resubmitted work does meet the competency requirement, the original mark will be retained for that section.
3. Resits of tests or sections of tests will be conducted during the designated non-teaching period.
4. To assist in preparing students for the tests and for the examination, booklets of revision questions with suggested answers were prepared and handed out to the student at the beginning of each topic. These questions were used both as formative exercises within the context of the classroom and in out-of-class study. Prior to each test, a sample test was provided together with a sample of answers for the student to pursue and use for formative feedback.

5.7 PRODUCTION OF ASSESSMENT INSTRUMENTS

5.7.1 Introduction

Once the assessment blueprint had been developed, it was time to formulate the assessment prompts and develop the assessment instruments. Throughout this process, the developer should consider the manner in which the assessment questions or instructions are presented to the student and what additional stimulus materials will be needed. So far in this report, questions such as how the students will respond, how such responses will be recorded, how responses are scored, the criteria used to judge student responses, and the number of scale points for scoring student responses, have been discussed.

The number of assessment instruments depended on the number of tests, laboratory exercises and assignments. The assessment plan for the courses in this study was for three tests, but this number increased as a sample test for formative assessment and a second test for legitimate absences were created, as well as a resit test for each section, two written assignments and 12 laboratory exercises. Each of these documents made allowance for marking.

5.7.2 Examples of Assessment Instruments

This section provides a short summary of the layout of the assessment instruments used for tests, laboratory exercises and assignments. Examples of assessment instruments are included in the appendices.

There was a general approach to the layout of all assessment instruments. Tests were always prepared as an A4 booklet printed on A3 paper whereas laboratory exercises and assignments were printed on A4 paper and stapled at the top left corner. Students were encouraged to remove that staple, place their written material behind the cover sheets and re-staple all pages together.

The front cover of each assessment was descriptive of the assessment, the topic, marks to be allocated, etc and was designed to provide a cover to the assessment so that no student work or marks was visible when closed. This provided protection for both myself and for a student in that no other student was able to see another student's mark when passing material back to the student or if material was lying on a desk. The only personal information was the area set aside for the student's name at the top of the page. Tests and assignments were teacher marked, whereas laboratory exercises were self- and peer-marked prior to the exercise being handed to the teacher for check marking.

Tests were printed so that each part focused on a specific learning objective, details of the competency requirement were provided, questions were outlined and presented, areas were provided for student responses, 'marks out of' clearly indicated, and a single line scoring register printed after each question. On page 3 inside the front cover the full test scoring register provided the individual part scoring together with competency indication, and a summary line provided the overall marks for the test.

Assignments were printed with information on the assignment and assignment topic, marks, etc. on the first or more pages, and the full marking register presented on the face of the last page. The first part of the register provided individual scoring and allocation of marks for the introduction, discussion, conclusion, calculations, and format of the student's work. The second part of the register provided the summary of the marks. If any part of the work was not up to a minimum 'C' standard, the work was returned as a 'resit' for that part to be reconsidered. Students were also provided with a document outlining information for producing an assignment which also contained more detailed descriptors for the rubric scales used with assignments.

Laboratory exercises were also printed with information on the front page outlining the subject of the exercise, exercise number, etc. At the bottom of the page was a three-step checklist for the student to tick as they worked through the exercise, together with a box at the bottom which the teacher initials when the exercise had been completed to at least a competent standard. At the end of each section a marking register was provided which also indicated the total marks for each element. At the end of the document a summary of assessment scoring register was provided.

For the purposes of the two courses directly involved in this study, the following assessment instruments were developed for the Direct Current Circuits and Digital Electronics courses.

- Tests Three sets of tests to cover the subject content. Each set contained a sample test handed out to students prior to the test period for revision and familiarisation purposes, the test used at the prescribed time, a further test for those who could not attend the prescribed time, and a fourth test used during the period set aside for resits. A total of 24 tests for the two courses.

- Assignments Two assignments were set for each of the two courses.
- Laboratory exercises. Twelve exercises were developed for each of the two courses.

5.7.3 Administering Performance Assessments

Once a performance assessment and its accompanying scoring rubric are developed, the assessment is ready to administer to students. There are several recommendations that are specifically developed to guide the administration of this process (Moskal, 2003).

1. The assessment instruments were specifically established against the learning outcomes as derived from the two diplomas and in that respect would reflect a valued activity.
2. The completion of performance assessments was deemed to provide a valuable learning experience for the students by virtue that they have been based on typical questions that are and have been considered desirable for many years.

3. Through the list of learning outcomes and the associated matrix, goals and objectives have been clearly aligned with the measurable outcomes of the performance activity.
4. As far as I had been able to plan and prepare the assessment instruments, the examination of extraneous or unintended variables has been minimised and the assessments are fair and free from bias.

Other considerations were taken into account when developing the assessment instruments.

1. Both written and oral explanations of tasks should be clear and concise and presented in language that the students understand. If the task is presented in written form, then the reading level of the students should be given careful consideration. Students should be given the opportunity to ask clarification questions before completing the task.
2. Appropriate tools need to be available to support the completion of the assessment activity. Depending on the activity, students may need access to library resources, computer programs, laboratories, calculators, or other tools. Before the task is administered, the teacher should determine what tools will be needed and ensure that these tools are available during the task administration.
3 Scoring rubrics should be discussed with the students before they complete the assessment activity. This allows the students to adjust their efforts in a manner that maximizes their performance. Teachers are often concerned that by giving the students the criteria in advance, all of the students will perform at the top level. In practice, this rarely (if ever) occurs.

These recommendations are consistent with the Standards of the American Educational Research Association, American Psychological Association and National Council on Measurement in Education (1999) with respect to assessment and evaluation. The final recommendation is consistent with prior articles that concern the development of scoring rubrics (Brualdi, 1998; Moskal, 2003; Moskal & Leydens, 2000).

5.8 SUMMARY

This chapter has outlined some of the development that occurred during the process of developing the working model to meet the demands of the simultaneous, dual assessment requirements of the two diplomas. There was much more that could have been done, if the assessment had not been so constraining, with more attention to authentic and alternative assessment. Nevertheless, the working model did set the stage for the course through the learning opportunities and the administration of the assessments. This chapter set out to document the processes whereby the reference to the simultaneous dual assessment of "it can't be done", was moved towards "there has to be a way". By the end of this chapter, I believe there is sufficient evidence to suggest that 'there is a way'.

CHAPTER 6

THE WORKING MODEL - EVALUATION AND REFLECTION

6.1 INTRODUCTION

This chapter will present answers to a few of the many questions that could be raised from a study such as this. As a researcher, as the practitioner in the centre of the case under study, as a source of valuable data and as the writer of the report, I would like to present data that can assist readers to appreciate and analyse real problems and events faced by teachers, and to contribute to the real world of others through orderly feedback. The methodologies of case study and action research in particular support the contribution to the professional development of others.

The theoretical model presented many different categories of data, and as a teacher it takes time to sort out the data and apply it in the learning environment. The working model seemingly ignored many of the categories, yet many of these were present while the focus was placed on the major difficulty, that of overcoming the problem of simultaneous, dual assessment. Several questions come to mind regarding the theoretical and working models and I will attempt to answer some of these here. The questions I will address are:

1 What are the implications of the theoretical model?
2 How did students react to the requirements of self and peer marking, the use of the rubric, and getting organised to make efficient use of the self-paced laboratory time and out-of-class time?
3 What are the students' perceptions of the relative importance of the list of graduate skills as compared to prospective employers?
4 How reliable was the marking rubric in producing an acceptable mark for the assessment?

5 How did I as a teacher relate to the structure and mechanism of the simultaneous dual assessment, the use of the marking rubric, and to the learning environment as a whole?

Accordingly, Section two will discuss implications of the theoretical model and a presentation of the results of the student feedback of the learning/assessment environment is presented in Section three. The students' perception of the importance of skills is presented in Section four, together with a comparison against the employers' perception. An analysis of the reliability of the assessment-scoring rubric is outlined in Section five and in Section six I offer some personal reflections as to my perception of the learning/assessment environment. Section seven provides a short summary of this chapter.

6.2 IMPLICATIONS OF THE THEORETICAL MODEL

The theoretical model that evolved from the grounded theory research is acknowledged as a complex model that could be considered overwhelming and impossible to attain. It does however meet the needs of a case study approach in that the in-depth study has allowed the finding of 'hidden' documents and the establishment of fundamental objectives.

I suggest that this theoretical model be used in a similar way that goals and objectives are used for course planning. These are neither intended to set an impossible expectation for a student to achieve nor to make it difficult or impossible for the teacher to facilitate, but rather to focus both teacher and student on goals and objectives in order to have a clear focus for learning and assessment. The theoretical model should therefore be seen as a goal and a set of objectives in order to set a clear focus on a continuing action research culture for the teaching/learning environment. The model also identifies discrepancy between principles and this is especially so between institutional policies and strategies, and those that focus more on student learning. Because of these discrepancies, there are implications for institutional administrators to accept as well. The theoretical model can also allow generalisations from this particular case to other teaching/learning cases. For myself, the consultation of resources with a focus on determining data and categories and finally a theoretical model has 'opened my eyes' to the teaching, learning and assessment environment of the classroom. In hindsight, it is a cause for regret that I had to find this knowledge by myself at the end of a teaching career instead of it being provided to me as professional development throughout my career.

6.3 STUDENT FEEDBACK OF THE LEARNING/ASSESSMENT ENVIRONMENT

6.3.1 Introduction

Student assessment or evaluation of the learning/assessment environment was undertaken in two phases. Phase one occurred approx four weeks into the course when the students completed a simple questionnaire covering topics such as demographic data, ability to undertake the mathematical calculations and understand the theory, the assessment requirements and the student's ability to organise themselves in study. Phase two followed a few weeks later and consisted of an informal interview with the students, offering them the opportunity to elaborate on their scoring of the questionnaire. The questionnaire consisted of 11 questions, with question 3 and 4 in two parts, and question 11 in four parts. Other than the first four questions on the students' demographic situation, questions were answered on a five-point continuum with different responses. These responses followed the pattern from a 'negative' to 'positive' viewpoint. Students were asked to circle the appropriate number of their response. Eighteen students signed an ethics acceptance form to be included in the research and these students completed the questionnaire.

The semi-structured interview suited this study as it provided a means to consider the issues covered in the student questionnaire, allowed the student to speak more widely on the issues raised by the questions, allowed flexibility in terms of the order in which questions were considered, and allowed for open-ended answers by the student to elaborate on their experiences (Denscombe, 2003). Because the students had been attending classes for some weeks before the interview, they had been experiencing first-hand the topics to be discussed. The interview was conducted in their 'territory', that is the laboratory, where there was a strong likelihood that the students would be socially comfortable and that there would be trust and rapport between the student and myself. Those students who agreed to take part in the research were given an opportunity to decline from taking part in the interview, resulting in nine students who agreed to be interviewed.

6.3.2 Presentation of Student Feedback

In presenting this analysis, the data from each question or group of related questions in the questionnaire are presented in turn. Where a question was discussed during the interview, these comments are presented at the same time. This applies to questions seven through to 11. Where quoted text transcribed from the interview is presented, punctuation has been minimised and the use of a '▪' denotes a short pause, while a '▪ ▪' denotes a longer pause in the spoken comment. In some places intermittent background noise from outside traffic and students busy working inside has made the transcription impossible and this is denoted as [untranscribable]. Transcript lines beginning with 'I' are associated with the interviewer, while lines beginning with 'S1', 'S2', etc. are associated with individual students.

Questions 1 and 2

The first two questions were aimed at soliciting basic study data from the student.

1. Are you studying full-time or part-time?

   Full-Time 1
   Part-time 2

2. Have you commenced the first year of study in the Dip Tech programme this year?

   Yes 1
   No 2

There were 16 full-time students and two part-time students. Of these students, 12 had commenced the first year of study that year and six had commenced study in a previous year.

Questions 3 and 4

These questions focussed on the students' background and their transition from their previous experience into the teaching/learning environment of the current study year. (For the purpose of confidentiality, the name of the teaching institution has been blanked out.)

3. Circle the number next to the statement that best describes your background before commencing the Dip Tech programme this year.

I was attending secondary school last year.	1
I was studying at [redacted] or another tertiary education institution last year.	2
I was working/unemployed last year and have commenced study full-time this year.	3
I am employed and am studying part-time.	4
Other background.	5

4. How would you rate the transition from your previous experience (last year) to the teaching/learning environment of this year?

It has been and still is extremely difficult.	1
It has been difficult.	2
It was difficult but I am coping.	3
It has been reasonably easy.	4
Easy, straightforward, no problems.	5

The data from question 3 produced unanticipated results in that even though the diploma is presented as being suitable for school leavers, less than half the students (seven) had spent the previous year attending secondary school. Seven other students were studying at [MYTEC] or another institution the previous year and the other students were either working or unemployed the previous year.

The transition for the students from their previous experience to a tertiary environment where they are responsible for their own learning, self paced learning, etc, proved difficult for one student and yet this student had already spent two years studying electrotechnology subjects at a lower level. Seven other students indicated that the transition was difficult but they were coping. The other students either indicated that they found the transition reasonably easy, or easy with no problems. Those students who found the transition from their previous experience least difficult had spent at least one year away from secondary school. The inference here is that while the theoretical model contains many good practices such as those for adult learning, collaborative learning and student-centred learning, students straight from secondary school need to be nurtured into the different type of learning environment.

Questions 5 and 6

These were presented because of an interest in enquiring into each student's perception of their ability to do the mathematical calculations and to understand the theory in the courses.

5. If you are studying **Digital Electronics**…
   i. How would you rate your ability to do the mathematical 'calculations'
      - Extremely difficult 1
      - Very difficult 2
      - Difficult 3
      - Reasonably easy 4
      - Easy, straightforward, no problems. 5

   ii. How would you rate your ability to understand the theory?
      - Extremely difficult 1
      - Very difficult 2
      - Difficult 3
      - Reasonably easy 4
      - Easy, straightforward, no problems. 5

6. If you are studying **Direct Current** Circuits …
   i. How would you rate your ability to do the mathematical 'calculations'
      - Extremely difficult 1
      - Very difficult 2
      - Difficult 3
      - Reasonably easy 4
      - Easy, straightforward, no problems. 5

   ii. How would you rate your ability to understand the theory?
      - Extremely difficult 1
      - Very difficult 2
      - Difficult 3
      - Reasonably easy 4
      - Easy, straightforward, no problems. 5

The results indicated that in the earlier stages of the two courses, the general student perception was that there was no difficulty.

Table 6.1

Summary of Student Responses to Questions 5 and 6

Response	Q5.i	Q5.ii	Q5.i	Q6.ii
Extremely difficult	0	1	0	0
Very difficult	0	0	0	0
Difficult	4	4	3	3
Reasonably easy	12	13	10	13
Easy, straightforward, no problems	2	0	4	1

Questions 7 to 11

This group of questions in the student questionnaire focussed on aspects of the assessment framework and it was these questions that became the focus for the student interviews.

Question 7 - the clarity of understanding the assessment framework

7. How well do you understand the coursework assessment framework, i.e. what tests there are and the topics to be tested, the need to research and produce assignments, and the need for laboratory assessment?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

One student indicated, "I do not understand it at all", 5 responded, "It still is confusing", 9 with "It is reasonably easy to understand" and 4 responses for "Easy, straightforward, no problems".

Interviews about clarity of understanding the assessment framework

Student 1…

I (question) Number 7 ▪ ▪ understanding the assessment framework ▪ you have marked it as number 5 ▪ ▪ you are quite happy about it ▪ no problems with it?

S1 Yes ▪ ▪ straightforward ▪ it's easy to understand ▪ ▪ no real problems so far.

Student 2…

I Question 7 ▪ you've marked number 4 ▪ for understanding of the assessment framework ▪ any points that you want to add?

S2 Its really basically about one ▪ ▪ requirement as such ▪ handouts ▪ learning outcomes/objectives and what needs to be basically known and done as far as (untranscribable) That's why its easy enough to understand and that

I OK ▪ but on the same token you didn't mark it in number 5 ▪ so there must be some reason you felt it was only worth a 4

S2 No ▪ well basically if you've got to know something ▪ straight away ▪ like you give us a list of learning outcomes and requirements and whatnot ▪ you may not know what one particular learning outcome or requirement actually is.

I OK ▪ so could I do it better ▪ ▪ as a means of improving it?

S2 I don't know ▪ you would have to spend a lot of time going over each individual's ▪ ▪ what they didn't understand as far as what they had to know.

Student 3…

I Item 7 ▪ you have circled number 4 ▪ that it is reasonably easy to understand the course assessment framework ▪ is there anything about that framework ▪ in other words the tests you are going to do and so on ▪ that you don't understand.

S3 The only part that I don't understand about ▪ or have a little bit of difficulty about this framework is just ▪ how the Unit Standards and marks are tied together ▪ I'm actually doing them now ▪ but its just taking a little longer to work out how they tie into each other.

I So I could of spent a little bit more time explaining this right at the beginning?

S3 I am not sure that it actually ▪ that ▪ like you did actually ▪ ▪ explain it quite well but it was just a matter of getting my head around it ▪ and now I actually tending to understand it a little bit more.

Student 4…

I Item 7 here ▪ with regards to the coursework assessment framework ▪ you have circled that it is reasonably easy to understand ▪ got any comments on that ▪ like is there something that you still don't understand or was it difficult to come to grips with in the first place?

S4 Is that like the work from our labs?

I This is the overall framework ▪ like the tests you are going to do with the topics etc ▪ etc ▪ etc.

S4 No its pretty straightforward ▪ eh ▪ pretty much outlines everything you have to do.

Student 5…

I Number 7 ▪ how well do you understand the coursework assessment framework ▪ you have indicated number 3 ▪ its still confusing ▪ can you elaborate on that ▪ tell me what may have been confusing about it.

S5 I think it was more different from the schoolwork –

I You have just come straight from school?

S5 Yes they do it a bit different there ▪ ▪ how do I explain it ▪ ▪ well actually I'm not quite sure ▪ I think ▪ its not quite so much confusing ▪ it was just a little bit confusing to start with ▪ I wasn't quite sure like ▪ what was needed.

I Could I then ask the question ▪ do you think I could have presented all this information in a lot better way and made more effort to explain it better?

S5 Not really ▪ you've done pretty good well (untranscribable) so it pretty understandable ▪ so I could have probably put 4 on that one there.

Student 6…

I Number 7 ▪ understanding the assessment framework ▪ you have indicated a 4 ▪ reasonably easy to understand ▪ do you want to add anything to that?

S6 No not really ▪ it is pretty easy ▪ it's set out quite nicely and all that ▪ ▪ course outlines and everything like that ▪ so you've prepared this well.

Student 7…

I Question number 7 ▪ the understanding of the assessment framework ▪ you have marked it as a 4 ▪ reasonably easy to understand ▪ was there something about it you couldn't understand or ▪ are you finding it better now?

S7 It's better now ▪ I only put it as reasonably easy to understand because it was the first I had seen that sort of ▪ how it worked ▪ and it was new but it wasn't that it wasn't easy.

Student 8

I Question 7 ▪ the coursework assessment framework ▪ you indicated a 4 there ▪ it is reasonably easy to understand ▪ is there anything you didn't understand about the framework?

S8 I actually can't quite remember what is was ▪ ▪ I was quite confused about the whole thing about the [some almost untranscribable reference about marks]

I And the two diplomas

S8 And your idea ▪ I wasn't quite sure whether I was right or not ▪ ▪ but umm its alright now

Student 9…

I Question number 7 ▪ about the coursework assessment framework ▪ you have marked it as a 4 ▪ that it was reasonably easy to understand ▪ can you think of anything in particular that may have been difficult?

S9 To understand?

I To understand about the overall framework of the assessment?

S9 When it was explained to me how ▪ ▪ you explained to me something about how there being two diplomas or something like that ▪ it was pretty hard to understand that first.

I Do you understand it now?

S9 No not quite yet ▪ [untranscribable]

I So perhaps I could have ▪ make that a little bit clearer.

S9 Mmm [affirmative]

Comments on Question 7

It would appear that given the time and effort I put into preparation of material and discussion regarding the coursework assessment, more effort could be put into making sure students understand the assessment framework and process.

Question 8 - understanding of the use of the marking/scoring rubric

8. How well do you understand the use of the marking/scoring rubric in making a valid judgement about the 'quality' of a piece of assessment?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

There were no responses for 'not understand' or 'difficult to understand' and five students indicated, "It still is confusing". The remainder of the students were more confident. Nine responses for "It is reasonably easy to understand" and four responses for "Easy, straightforward, no problems". Those students who found the marking rubric confusing came from a mixed background of previous experiences.

Interviews relating to the understanding of the marking/scoring rubric

Student 1…

I Number 8 ▪ the marking scoring rubric ▪ you seem to indicate you have no problems with that. Do you think it's a pretty easy thing to use?

S1 Yes ▪ it's self-explanatory ▪ it's understandable ▪ you've given us this sheet that helps explains it.

I Compared to how the lab work was marked last year ▪ have you got any comments?

S1 This year you've got your own peers helping you out ▪ either they think its good enough or not ▪ ▪ if not you know ▪ you've got your peers pushing yourself through it ▪ its good this year marking between us ▪ what's wrong ▪ what's right

I And you think that's better?

S1 Yeh ▪ it gets you more involved ▪ ▪ your peers can push you a little bit harder than what you can ▪ ▪ push you to do better work.

Student 2…

I Number 8 ▪ the scoring rubric ▪ when you wrote this out you said it was still confusing ▪ ▪ is it still confusing?

S2 No ▪ I've since picked up basically how it works ▪ when I actually filled that out I didn't really understand it at all and that was because I hadn't read the handout you had given me ▪ and if I had probably read it straight away ▪ then I would have understood it better straightaway.

Student 3…

I Number 8 then ▪ about the scoring rubric ▪ again you circled 4 ▪ that it is reasonably easy to understand ▪ ▪ is there anything that you don't understand ▪ like have you learnt a bit more over the last few weeks?

S3 Yes ▪ I have actually learnt a bit more ▪ once again it's a new experience to me just getting my head around the idea ▪ but I am actually getting the hang of it now ▪ and yeh its getting easier to work out.

Student 4…

I Number 8 ▪ the marking scoring rubric ▪ and the question was 'how well do you understand the use of it' and you marked 4 again ▪ its reasonably easy to understand. You have no problems with it?

S4 No its straightforward ▪ as long as you follow the marking rubric.

I OK ▪ have you ever come across something like that before?

S4 Only thing is I pretty much thought was ▪ that if you weren't sure whether the answer was ▪ actually correct ▪

I OK

S4 Like if you had to make a written description in the lab ▪ like for an actual result ▪ that's all [untranscribable] no way of knowing yourself whether it was right if you have done it right or not ▪ if you've marked it compared with what you have done yourself ▪ you don't know if yours is right or you don't know if theirs is right.

Student 5…

I Item 8 on the marking scoring rubric ▪ you've indicated a 3 ▪ reasonably easy to understand ▪ you're quite happy with that?

S5 Pretty basic marks ▪ like A ▪ B ▪ C and do your research yourself.

Student 6…

I Number 8 ▪ the marking scoring rubric ▪ ▪ again you have mentioned a 4 ▪ its reasonably easy to understand.

S6 No real problems ▪ just refer to it and that sorts out the level [untranscribable]

Student 7…

I The understanding of the marking/scoring rubric ▪ you indicated then it was still confusing ▪ do you know what actually was confusing?

S7 Yes ▪ just that you ▪ not working in percentages and working with letter and ▪ it's different but I understand it now.

Student 8…

I Number 8 ▪ the marking/scoring rubric ▪ you indicated 5 no problems ▪ have you used this sort of thing before?

S8 No I didn't ▪ I found it's pretty straightforward when you understand it.

Student 9…

I Number 8 ▪ and the marking/scoring rubric ▪ you indicated 4 ▪ reasonably easy to understand ▪ do you have any major problems with it?

S9 No ▪ good as gold ▪ that was pretty straightforward.

Comments on Question 8

The comments suggest that from those interviewed, there were few problems after a few weeks of settling into the course and using the rubric. Some students initially didn't understand or did not refer enough to the handout material. It would appear here that more care and attention should also be given to introducing the concept to the students.

Of particular interest were the comments about how the use of a rubric and the self- and peer-marking pushed a student into doing better work, and the comment about how even with peer marking there can be some confusion over whether the correct answer had in fact been identified.

Question 9 - perception of the use of the scoring rubric in the laboratory.

9. Your peers are marking laboratory exercises. How do you rate the validity of this method of assessment?

The method of assessment is not at all valid and my grade is not acceptable.	1
I find it difficult to understand	2
The method is valid but my grades could be better	3
It seems to be valid and my grades are OK.	4
It is a valid method, my grades are OK and I am learning from doing it.	5

Two students found the concept of peer assessment difficult to understand and one student was happy with the validity of the assessment, but their grade could be better. Ten students agreed that it seems to be valid and their grades are OK and five indicated they considered that it is a valid method.

Interviews relating to the use of the scoring rubric in the laboratory.

Student 1…

I Number 9 in terms of having the exercise marked ▪ ▪ and the validity of it ▪ you've indicated it at number 4 ▪ seems to be valid and grades OK ▪ is there any area there where you are not sure of or could be improved?

S1 Oh ▪ various areas ▪ if ▪ I've had an argument with my mate the other day ▪ if we both get it wrong ▪ how do we know which one is right ▪ that's when we have to come and see you.

Student 2

I Number 9 ▪ having peers mark your laboratory exercises ▪ you've indicated a 4 ▪ ▪ any comments on that?

S2 No ▪ not really ▪ again once I understood it ▪ it wasn't a problem ▪ its easy to understand what is required as far as marking assessment is required.

Student 3…

I Number 9 here ▪ you've circled 5 ▪ you are obviously happy about it ▪ you are happy about the method and so on?

S3 Yes yep ▪ no troubles there.

Student 4…

I Number 9 the fact your peers marking your lab exercises and it asked about the validity of the method ▪ and you have marked it reasonably valid and your grades are OK ▪ you are quite happy about that?

S4 Yes as long as the other person knows what they are doing.

I Do they know what they are doing?

S4 I guess so ▪ it's pretty straightforward.

Student 5…

I Now as far as other people marking your lab exercises ▪ in number 9 here ▪ you've marked a 4 ▪ seems to be valid and your grades are OK ▪ you are quite happy about the different [untranscribable] and your grades are OK?

S5 Yep ▪ they have to do the work as well so they know what was expected.

Student 6…

I Number 9 ▪ the marking of each other's lab exercises ▪ you have marked as 2 as difficult to understand ▪ is there a little problem with this?

S6 Aw ▪ its more on a scale of 1 to 5 on the validity on students marking other students work ▪ ▪ some people can cheat ▪ some people can muck about ▪ they can get grades for the highly rated parts and bad grades with the others to make it look like they have marked it but not really ▪ and also being a student but not actually having the background knowledge ▪ just make mistakes easy ▪ and things like that ▪ mistakes that would mean that you would have to do it again.

I Are you aware of anybody who is actually doing it deliberately

S6 cheating?

I You are just expecting it could happen?

S6 Yeh ▪ because it's just one of those things ▪ abusing ▪ the system.

Student 7…

I Item number 9 ▪ having your lab work marked by your peers ▪ you have indicated a 4 ▪ it seems to be valid and your grades are OK ▪ you are still happy with it?

S7 Yep ▪ still happy with it.

Student 8…

I Number 9 with your peers marking your lab exercises ▪ you have indicated 5 ▪ there seems to be no problems?

S8 No problems ▪ I find its better with someone else in my class marking my work because they give me good feedback ▪ I can see how I can do things better ▪ explain theory and learn a bit my way myself.

Student 9…

I And [question] 9 ▪ your peers marking your lab exercises ▪ you indicated a 3 ▪ that you ▪ when you started ▪ that you think your grades could be better ▪ are you ▪ do you think you are being marked too hard or was it that you weren't sure of what you actually have to do?

S9 Umm ▪ ▪ probably I wasn't quite sure what I was supposed to do ▪ like ▪ I think I know now ▪ so its pretty easy ▪ now ▪ and easy to understand now.

Comments on Question 9

After some initial confusion and/or uncertainty, students' comments are positive about the use of the rubric as a scoring instrument. The one student who commented on the possibility of 'cheating' presents an interesting insight into possible abuse of the system. In terms of laboratory exercises where the students predominantly do the marking, the possibility of cheating would be minimised by the checking procedure prior to the recording of the marks.

Question 10 - the marking of other student's laboratory exercises.

10. You are required to mark other student's laboratory exercises. How well do you understand what is required from you in this marking process?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

No student considered that they did not understand the process at all, one student found it difficult to understand, and three students indicated that it was still confusing. The majority of the students indicated that there was no misunderstanding with 11 students finding it reasonably easy to understand and three students considering it to be easy with no problems.

Interviews relating to the marking of other student's laboratory exercises.

Student 1…

I The question about marking other peoples work ▪ again its reasonably easy to understand how to in fact do it but you said you've got this problem of what to do if both people are wrong.

S1 Yep

I Any other comments to add to number 10?

S1 Nay ▪ that's pretty much it.

I Number 10 ▪ the whole business of doing the marking of other peoples exercises and you have indicated a 4 ▪ is there anything you need to understand or what needs to be done?

S2 Yep

I Is it still bad or has it got better ▪ or what?

S2 I probably over marked myself on that one and it's probably up to the mark and when I filled that out it probably should have been a 3.

I OK ▪ ▪ so its more a case of reading to understand and than not being given to you correctly.

S2 Yeh oh no ▪ no ▪ when it was first ▪ its purely my own fault for not reading stuff when its given to me ▪ that really all it comes down to.

Student 3…

I Having to mark other peoples exercises ▪ you have marked that as a 4 ▪ that it is reasonably easy to understand the process ▪ ▪ how do you find that now?

S3 Not too bad actually ▪ I've found its actually easier that I first anticipated ▪ ▪ yeh ▪ no troubles at the moment.

Student 4…

I Again this is the other part of marking other people's work yourself ▪ and you're happy about it ▪ you've marked 4 ▪ you have no problems with marking other peoples work?

S4 Its basically the same thing about not knowing if it's not actually right or not…

Student 5…

I Number 10 ▪ in the other perspective ▪ you have to mark other peoples work ▪ you've marked it 3 ▪ it's still confusing ▪ is it still confusing now ▪ or are you learning a lot more?

S5 Its getting a bit better ▪ its just a little bit confusing because you're not sure actually what's correct ▪ like the correct answer ▪ it could be hard ▪ you're not sure what to do.

Student 6…

I Number 10 ▪ when you are marking other peoples work ▪ you have marked that as a 3 ▪ it is still confusing ▪ do you want to add something to that?

S6 Yeh ▪ I'm not quite sure exactly how well I'm supposed to mark it ▪ I mean I can have a quick look to see if it is all there ▪ and because it's on some of the grades are A to C on how good your answer is ▪ because I don't really have a knowledge on how good a particular answer is ▪ if it's a good answer and I can understand it I just give it an A.

Student 7…

I Number 10 ▪ marking other people's work ▪ you have indicated 5 ▪ no problems at all.

S7 Yep ▪ I find it quite straightforward.

I So what seems to be making it easy?

S7 Just working together ▪ ▪ it's easier than just handing it in getting it back before we get more feedback.

I OK ▪ so you think you are actually learning more?

S7 Yep

Student 8…

I Number 10 ▪ you marking other people's work ▪ you indicated a 4 ▪ its reasonably easy to understand what to do.

S8 Its reasonably easy ▪ there's still a few things ▪ ▪ I don't get the ▪ why we ▪ its out of 90%

Student 9…

I Number 10 ▪ you have indicated a 4 ▪ you are quite happy about marking other peoples work

S9 Umm ▪ yeh ▪ cause I see what they are doing ▪ so ▪ ▪ I can see where I'm at ▪ I compare my work to theirs ▪ see how I'm marking theirs ▪ and I need to do my work better when their work is a higher standard than mine ▪ then ▪ marking theirs obviously helps myself and kinda helps my understanding.

I So you think that because you are working with somebody and marking their work ▪ its helping your standards to be lifted.

S9 Mmm ▪ yeh ▪ yeh.

Comments on Question 10

Once again, the comments provide an interesting set of comments rather than any conclusive answer. Overall the comments would suggest that students are benefited by the process of marking their peer's work.

Question 11 – Students' self organisation

The final question in four parts dealt with the students' self-organisation in the learning environment. These four questions were introduced with the statement:

"These courses require you as a student to become responsible for your own learning. Part of this responsibility is the discipline required to attend classes and make time outside of class to do revision, research for assignments and laboratory exercises."

Table 6.2

Summary of Student Responses to Part I of Question 11

i. How well do you rate yourself in terms of being organised with time so you are regularly attending lectures and laboratory periods?

Response		**No of responses**
I am extremely disorganised	1	0
I am very disorganised	2	1
I am still disorganised	3	3
I am reasonably organised	4	11
I am very organised.	5	3

Table 6.3

Summary of student Responses to Part II of Question 11

ii. How well do you rate yourself in organising sufficient time outside of class to 'stay on top' of required work?

Response		**No of responses**
I am extremely disorganised	1	0
I am very disorganised	2	2
I am still disorganised	3	7
I am reasonably organised	4	9
I am very organised.	5	0

Table 6.4

Summary of Student Responses to Part III of Question 11

iii. How difficult has this process of 'getting organised' been?

Response		**No of responses**
Extremely difficult	1	0
Very difficult	2	2
Difficult..	3	9
Reasonably easy	4	6
Easy, straightforward, no problems.	5	1

Table 6.5

Summary of Student Responses to Part IV of Question 11

iv. How different is this learning environment from your previous learning experience or background before commencing the Dip Tech programme?

Response		**No of responses**
Extremely different	1	1
Very different	2	1
Different	3	8
Reasonably similar	4	8
Much the same, no significant difference.	5	0

Interviews relating to question 11

Student 1…

I Number 11 ▪ being responsible for your own learning ▪ attending classes and so on ▪ you indicate you are reasonable organised ▪ ▪ anything you can think of that would help you to get better organised?

S1 Umm ▪ not from the teacher's point of view ▪ no it's more a personal thing.

I OK ▪ and the same thing ▪ work outside ▪ outside of class ▪ you've got marked as 4 ▪ that you're reasonably organised ▪ ▪ you are fairly happy about that?

S1 Yea ▪ once again it's a personal thing.

I OK ▪ and the process of getting organised you indicated it has been reasonably easy ▪ tell me this year ▪ from your past ▪ last year when you first started the actual diploma…

S1 Coming to tech is different than high school ▪ there's no teacher pushing you saying you have to have this done ▪ its more teachers schedule it and you have to go do it yourself ▪ you have to get yourself organised ▪ there's no one really pushing you ▪ like high school.

I OK. And the learning environment now from what you had before you commenced the Dip Tech program ▪ you've indicated its different ▪ is there anything you want to add to that to make it clearer what you mean?

S1 Once again ▪ teachers aren't pushing you ▪ so its your own ▪ you actually you own self motivated ▪ different learning styles ▪ there's more actual theory work where high school its more this is how its done ▪ if it doesn't go wrong ▪ like I don't know ▪ you've have to come and see me

Student 2…

I You are disorganised in number 11/2 when you are working outside of class ▪ and I guess that's manly due to work pressure?

S2 Yeh ▪ its work pressure ▪ and other courses and ▪ probably a bit of a lack of motivation actually coming back this year ▪ and there's no clear end in sight ▪ so you lack a bit of motivation ▪ ▪ in the end it's hard to come back after Christmas and suddenly get straight back into it ▪ and that's why I probably put that as disorganised.

I And again getting organised has been difficult-

S2 Yeh

I Is it still difficult or are you finding that getting back into it now ▪ it is starting to get better?

S2 For me personally its still quite difficult mainly because of work again ▪ and the other classes I am doing ▪ ▪ and getting a bit bogged down a little bit

I OK and the last one then ▪ the difference in this learning environment from your previous learning experience which would be probably prior to last year starting the Dip Tech ▪ made it very different ▪ ▪ have you got any comments?

S2 Main reason it is still different last year I did ▪ ▪ I started my courses I had quite a ▪ I already had a basic understanding of what I was going to do ▪ so I probably had quite a head start on others ▪ perhaps ▪ they do new stuff and you were just refreshing me ▪ but this year its all new.

I OK and so…

S2 and that's why it is difficult this year.

I It's difficult this year?

S2 Yep

I Last year it wasn't difficult mainly because you had a good idea of the theory anyhow.

S2 Yep ▪ yep ▪ I think that practical wise the theory makes sense ▪ because I'd done a lot of it ▪ practical ▪ maybe when I say practical at work and that those situations ▪ I probably didn't really knew what was going on and I knew what the outcome was going to be at the end of the day ▪ last year when I put the theory behind it ▪ then it made more sense and I knew from practical experience what the answer should be at the end of the day.

I That's fair enough ▪ now that's the theory side of it ▪ when we look more at the environment ▪ of how difficult it was to get organised and your learning was organised ▪ when you think back to the beginning of last year for the diploma and considered what we did last year against what your previous experiences were to that ▪ ▪ don't worry about the theory but look at the environment ▪ it is very much self-paced ▪ you are responsible for your own learning…

S2 That is the difference ▪ the previous tuitional classes that I done before that quite a while ago while I was still at school ▪ in that school ▪ you do this ▪ you do that ▪ they tell you what to do ▪ the teachers here are very different cause there's a lot more of having to do things yourself ▪ but as far as the environment goes you know your task and go and do it kind of thing.

I From a part-time student point of view ▪ though this gives you a flexibility ▪ also if you are very structured wouldn't give you the flexibility

S2 Nay

I And for you flexibility is very important?

S2 Well it is ▪ especially if you are part-time ▪ you know other commitments ▪ pay bills etc ▪ that's why I marked it that low.

Student 3…

I Item 11 on getting organised ▪ you have circled fairly high in all of those ▪ so obviously you are fairly organised.

S3 Yep ▪ yeh I try to be organised or else you ▪ it all goes to custard basically.

I And the last one on how different this learning environment is from your previous one ▪ you have circled 3 ▪ different ▪ ▪ have you got any comments on that?

S3 My last training provider as such was a training institute ▪ called [name given] training ▪ you would basically learn in the same idea ▪ you would learn work you would do your work and then be assessed on it ▪ to be extended ▪ ▪ this is a little bit quicker ▪ different ▪ ▪ a different training ▪ ▪ like a different course ▪

I Difference in say much self-paced ▪ is that quite different from what you had before?

S3 Yes it is actually ▪ like when you had before ▪ like there you do it once but here it not quite as ▪ ▪ forced ▪ to do this now then this ▪ again I am actually getting the hang of it now ▪ but when I first came here it was quite ▪ ▪ almost a shock actually ▪ trying to work out what actually I was meant to be doing etc.

I Do you find the self-paced environment ▪ now that you are getting used to it ▪ better than the rigid discipline system.

S3 They both have their positives and negatives ▪ ▪ I am trying to think how to define them as such but ▪ ▪ I haven't really got any ▪ ▪ proper ▪ disadvantages of either.

I So you are quite happy with it?

S3 Yep no no yeh ▪ I was a bit tongue tied there ▪ but I'm quite happy with it ▪ its just another way of learning ▪ and I don't mind it actually now.

Student 4…

I Number 11 about being organised ▪ you've marked 4 in every particular case ▪ you tend to be quite well organised ▪ is there anything I could have actually helped you at the start in getting better organised ▪ quicker?

S4 Um ▪ ▪ maybe certain ▪ on the actual date you have to have the lab in by ▪ so you don't sort of procrastinate and put it off ▪ like you probably find someone else has done.

I OK ▪ that's fair enough. So you think at the start…

S4 Not a date but say a the marks for a lab 1 to be due in by ▪ say week 2 or ▪ something like that. You know what I mean? So you don't go ▪ ah yea ▪ I can do it then and then if you don't do it, it is not marked.

I The ▪ the idea behind ▪ about the self paced lab work is that ▪ especially for those who work ▪ who are part time ▪ can be quite flexible in how they do it ▪ ▪ so setting a date actually then makes it then difficult for them.

S4 No I don't know about setting a date ▪ like ▪ say in three weeks you have to have a lab marked in ▪ like at the moment you don't really need to hand any marks in to you ▪ you know what I mean ▪ you haven't actually said you have to have any marks handed in ▪ so you probably find some people ▪ once they have completed the labs ▪ they've done them but they wouldn't have put the mark in or anything like that.

I OK ▪ what about the idea of giving you a lab and you don't get the next one until the first one is completely marked off?

S4 Yeh ▪ you could do that

I And then that means that you couldn't do the preparatory work at home ▪ reading through and reading up on it.

S4 Yea ▪ that's true too.

I Something to think about ▪ ▪ and the last one was about the learning environment compared to the previous learning experience ▪ and you said it was reasonably similar ▪ so you won't have found too much difference.

S4 I think it's a lot better actually because there's not so many people ▪ that's why I found it easy ▪ if there was more people if you had a problem ▪ and you are going to ask it ▪ if you don't understand it there and then you just get lost ▪ like here ▪ cause there's less people ▪ you get one to one help [untranscribable]

Student 5…

I Number 11 about being organised ▪ you've indicated a 3 in each of those ▪ are you getting better organised now as time goes on?

S5 Yep ▪ I was just a little bit not sure what I had to do but now I'm starting to get my stuff together ▪ I feel a bit better.

I Is there anything I could have done to make it easier for you to get organised quicker?

S5 I don't think so ▪ I think it just mainly myself ▪ still ▪ I have to organise it ▪ like ▪ ▪ its reasonably good ▪ like you gave us ▪ like you told us what we had to do ▪ and we just have to do it ▪ we had to organise it ourselves.

I Perhaps a little bit of procrastination because there's not a lot of deadlines in all the lab work ▪ you tend to put it off?

S5 Yep ▪ we don't have to ▪ like with the assignments and stuff ▪ we have to have it done by that date ▪ with the labs ▪ it's like kind of trying to finish it before the next labs due or something like that.

I And your learning experience this year is ▪ its reasonably similar to what you've done in the past ▪ you could say you actually haven't found it too different from this environment?

S5 No I've been into electronics stuff ▪ about too ▪ so make little things like that ▪ so in my 6th form work I done an electronics course and I've done a little bit of background knowledge and learnt the basics and things like that ▪ a lot of the stuff we're just learning now ▪ at the beginning ▪ I haven't seen before ▪ so it's not all confusing.

I What about the actual environment itself.

S5 The environment is a little bit different ▪ it's a lot more relaxed ▪ and more ▪ ▪ I guess it is a lot more relaxed and not in a bad way ▪ like in a easy going way.

I And that self paced is better

S5 Yep yep!

Student 9…

I From the organisational point of view ▪ you seem to be a little bit disorganised ▪ or you were when you filled this out ▪ are you still disorganised or you think your are slowly getting better?

S9 Slowly getting better but very slowly ▪ ▪ just my self-management ▪ ▪ and things ▪ ▪ like home.

The questionnaire data showed no obvious relationship between the students' change from their previous experience (part iv) and the other parts of the question. However when interviewing the students, the process of getting organised into the different learning environment proved difficult to some students.

Summary Comments

While the majority of students were comfortable with the introduction to the organisation of assessment, the marking rubric, and their marking responsibility to themselves and to others, there was a need for me to have been more disciplined in assuring that all students were supported through the change into this assessment culture. However, there is reinforcement that when self-, peer- and co-assessment are used in combination with each other, they can be effective tools in developing competencies needed as a professional (Sluijsmans, Dochy, & Moerkerke, 1998).

6.4 STUDENT PERCEPTION OF THE IMPORTANCE OF SKILLS

The primary focus for the employability skills survey was the need to determine a prioritised list of skills desired by industrial employers of graduate technicians. The secondary focus on this survey was to seek to understand how students view the same list of skills. For example, is there any significant difference between students' ranking of the skills and the future employers? Whether there is a difference or not, an understanding will give future direction into any changes to the teaching/learning environment so that the development of these employability skills is fostered and not overshadowed by intellectual demands for greater theoretical knowledge.

When presented with this survey, students were informed:

> "This survey questionnaire contains a list of skills or attributes that might be considered by a prospective employer when you initially seek a job position after graduating with a Diploma in Technology.
>
> The objective in asking you to complete this questionnaire is to formulate a profile of skills as considered necessary by students when first commencing their studies. This profile will then be compared with the skills profile obtained by surveying prospective employers to provide an understanding of the developmental process through which students must pass during their studies".

Responses were obtained from 23 students and the mean rating of those responses were compared with the employer data.

The most obvious data that students considered more important than did employers were for "project management skills", "academic learning", "capacity for independent and critical thinking", and "inter-personal skills with other staff". The data that students did not consider as important as employers were the personal attributes such as "personal presentation and grooming", "motivation", "enthusiasm" and "initiative".

It would appear from a generalised analysis of the results of the survey that most students consider that what they can learn in a classroom is more important that what they can do themselves personally in order to prepare for a future job. This is to be expected and rather than being any form of negative experience, it brings to thought the need to consider the many and varied ways in which the learning environment can assist students in preparing for employment. This then raises the question 'is the primary focus of a teaching institution on the student and their learning, or is the focus clouded by other issues'?

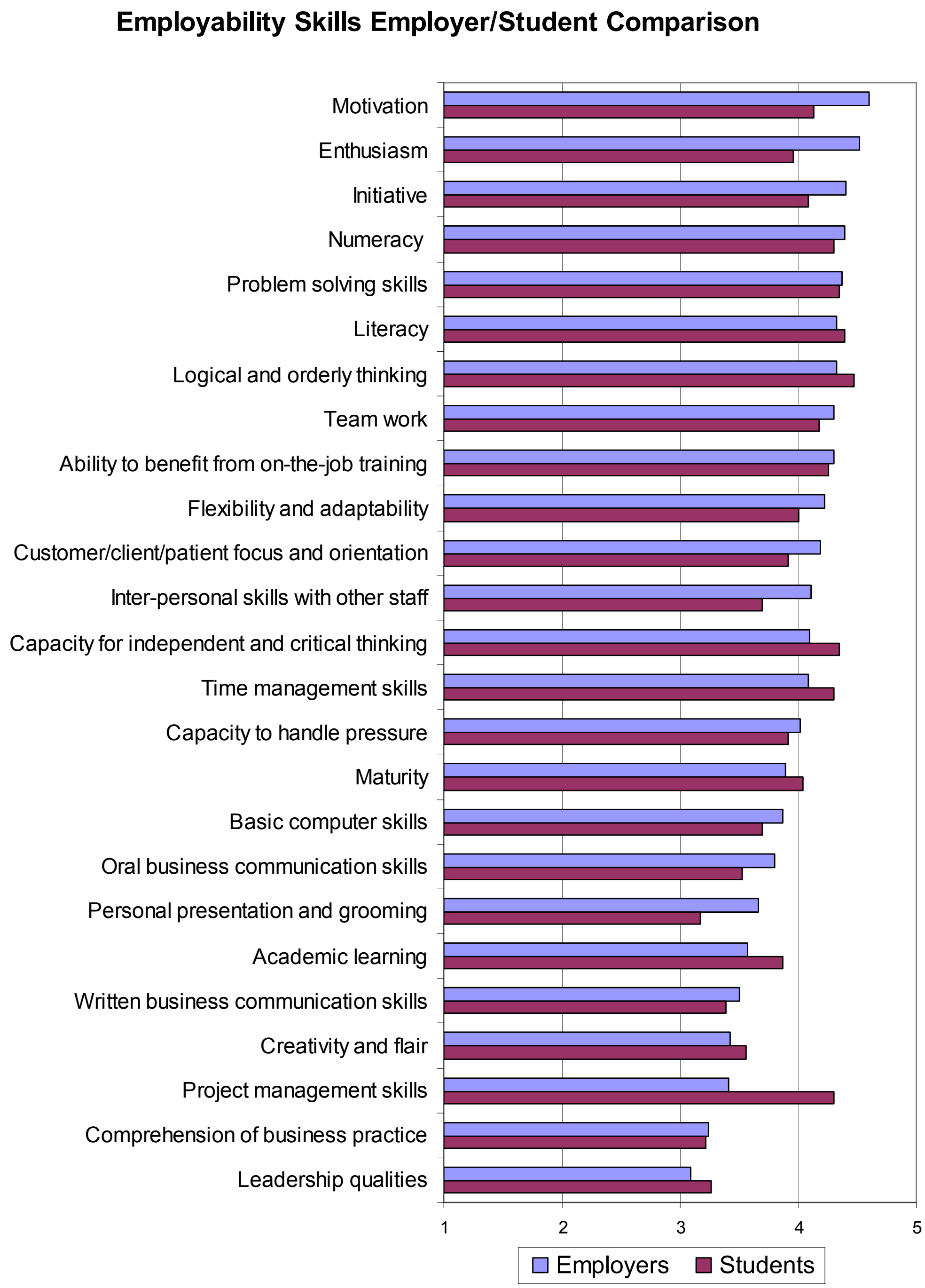

Figure 6.1. Comparison of employers and students ranking of the importance of desired employability skills, ordered by employer data

6.5 RELIABILITY OF THE ASSESSMENT SCORING RUBRIC

The concerns that can be presented in the use of a marking rubric in the manner outlined in this study, such as 'that of using students to mark their own or others work' and 'using a scaled rubric to assess students' work and to convert that to a mark', are valid concerns and should be addressed. The first concern 'that of using students to mark their own or others work', was addressed in the student questionnaire survey and in the case of the laboratory marking, all marks were checked by myself.

The responses from the student survey, analysis of scoring data, informal discussions with students and observations of students throughout the course, would support a range of benefits to teachers and students. These benefits can be summed up by referring to Trevisan, Davis, Calkins, and Gentili (1999), where although the term rubric is not used, the benefits of rubrics meet the same criteria. Benefits of clear scoring criteria include communicating faculty and program expectations to students, compelling students to achieve, providing teachable information to faculty, providing ready feedback on student projects with an efficient, accurate means of feedback that takes less teacher time and energy, and providing definitive lines to accountability for both students and faculty (Trevisan, Davis, Calkins, & Gentili, 1999).

The second concern of using a scaled rubric to assess students' work and to convert that scale to a mark can be addressed with reference to an analysis of marking data. Throughout the semester of the two courses being trialled, most of the tests were initially scored with the rubric and then re-scored using a traditional marking schedule. The two scores were then analysed and compared. If the assumption could be made that a score from a marking schedule was accurate, then the following graphs shows the accuracy of the rubric marks against those from a marking schedule for Test 1 of the Digital Electronics course.

The comparative analysis result for this test is based on 16 responses, and other than one outlier the analysis shows a reasonably linear relationship. The fitted line (mark from rubric = 1.0208 × mark from marking schedule) lies above the dashed line (mark from rubric = mark from marking schedule) and 0.9% of the variability of the mark from rubric result can be considered to be due to 'errors' in the marking system. This 'error' would favour a student rather than disadvantaging a student.

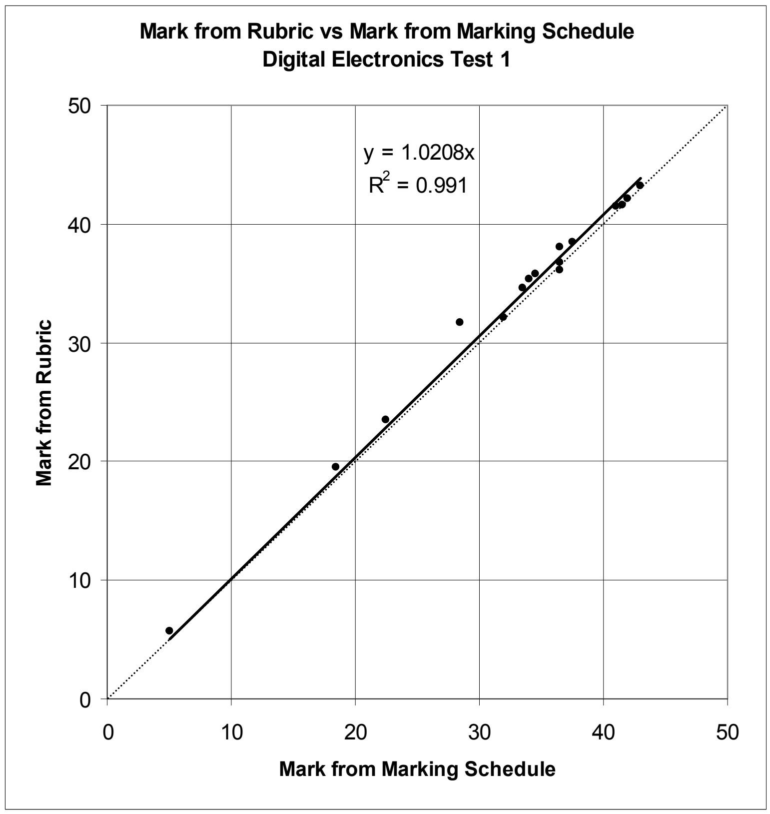

Figure 6.2. Comparison of marks from a rubric compared to marks from a marking schedule for Digital Electronics Test 1

The results from Test 2 are y = 1.0104x and R^2 = 0.9963, and for Test 3, y = 1.0052x and R^2 = 0.9879. These are very similar to Test 1.

When all marks from the three tests are considered together, there are more outliers yet the overall result improves slightly; y = 1.0215x and $R^2 = 0.9922$.

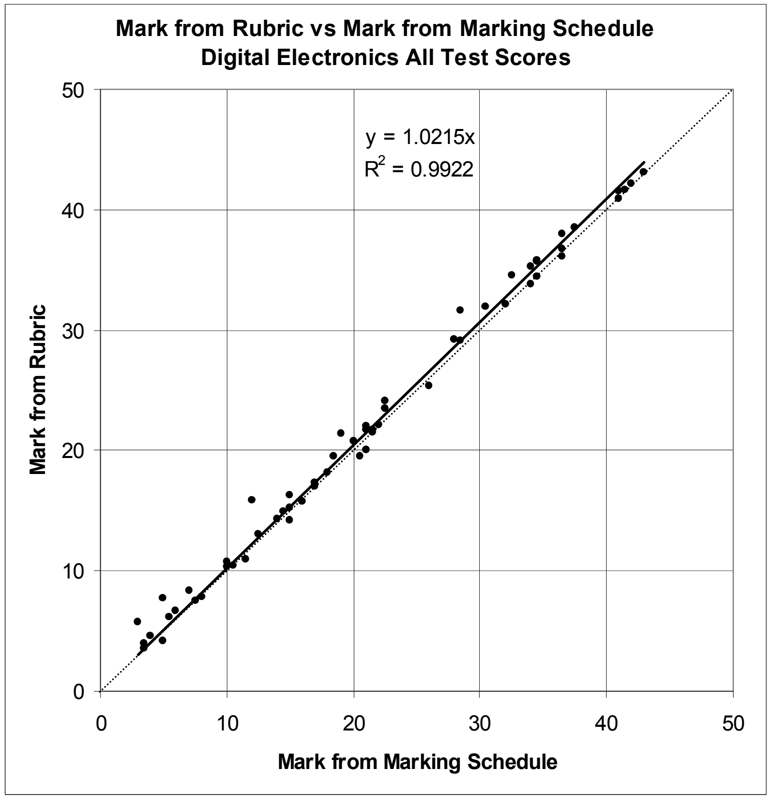

Figure 6.3. Comparison of marks from a rubric compared to marks from a marking schedule for all Digital Electronics Test results

When the test marks are summed to give a total result for the test component of the assessment, i.e. Test 1 marks + Test 2 marks + Test 3 marks, it would be difficult to argue that a student is disadvantaged with using the rubric scale to generate a test mark. In fact it would be difficult to argue that even the traditional marking via a marking schedule is in fact a fairer representation of the value of the assessment.

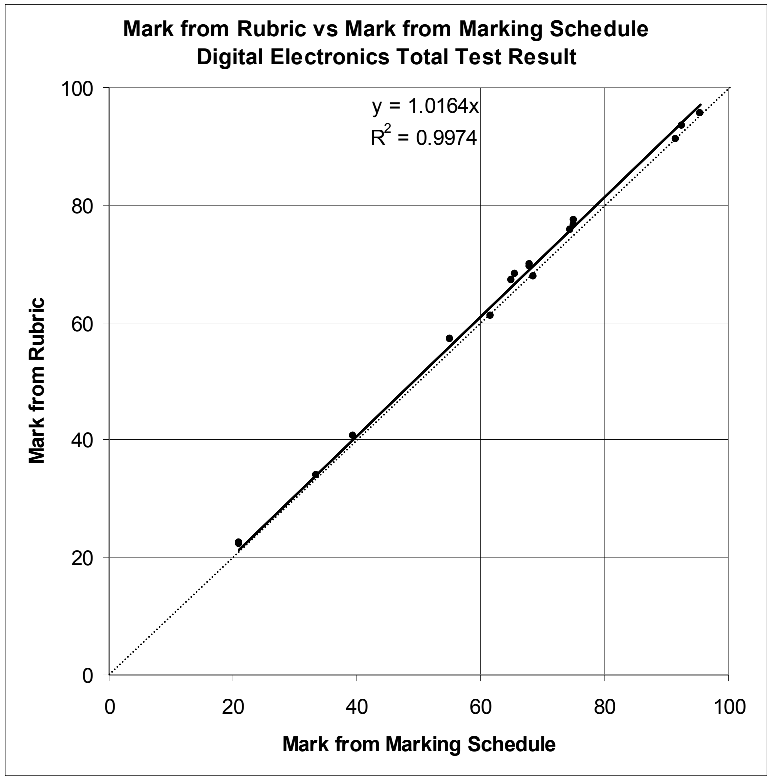

Figure 6.4. Comparison of marks from a rubric compared to marks from a marking schedule for the total Digital Electronics Test results

The regression analysis contains a variable R^2, which is known as the coefficient of determination. Correlation between the two marking system marks can be used as the measure of strength of the linear association between two quantitative variables. When the correlation (r) is computed from R^2, the result is 0.9987 indicating a very strong linear association between marks via a marking schedule and marks via the rubric 'grading to marks' process. The slope of the line, y = 1.0164x, reveals a slight tendency to favour marks from the rubric grading system, but this could easily be further minimised through experimentation with the grade rating factors.

It must also be noted that these test results are out of a maximum of 120 marks and need to be scaled to being out of 20% of the total course marks, all assuming that the use of a marking schedule to produce marks directly is the accurate and reliable method. Given the advantages of using a rubric in terms of ease of use, time saved for the teacher, feedback to students, etc, the use of a rubric to produce scaled grades that can then be used to generate marks can be justified.

> Our experience leads us to conclude that the use of the rubric in combination with peer assessment provides an effective teaching and learning strategy for this performance task (an oral presentation) in the setting of a college science classroom.
>
> (Hafner & Hafner, 2003, p. 1526)

6.6 TEACHER'S PERCEPTION OF THE LEARNING/ASSESSMENT ENVIRONMENT

Knowledge gained during the courses would suggest that students 'getting' organised is very much an individual characteristic that needs to be developed and one, which I suggest, is dependent upon their background. For example, the student who identified themselves as being in an extremely different environment from their previous experience, who considered themselves to be organised yet had some difficulty with the assessment regime, was a student I got to know as a person with a very good memory but little expertise in analysing new problems or applying knowledge to different scenarios. Besides some difficulties in the early weeks with students settling into the environment, I would have to say that the two courses during that semester would have been two of the most enjoyable courses that I had the privilege to be associated with. It would be fair to say that the check marking of the laboratory exercises was a good opportunity to discuss student's work rather than being more of a burden. Students were pleased to see that I could confirm the grade they gave each other, and if I felt the mark for an item should be changed to a lower one, there was little dissent. The conversion of the grade to a numerical mark was quick and easy. Grading and conversion to marks for the tests was also quick and easy. Students were accepting over the need to resit parts of tests and the record keeping of coursework marks for the two individual diplomas was also straightforward.

6.7 SUMMARY

This chapter presents an overview of the result of several attempts to find an answer to the problem of simultaneous dual assessment for the two diplomas, and this summary seeks to bring together the main points of the students' learning environment. One of the significant points that is regularly promoted as significant in the development, reflection and improvement of both a learning environment and the assessment of students both for learning and even for 'determination of worth', is the establishment of goals and associated objectives. Much of this summary reflects on the setting of goals as a necessary step in this process and also a sometimes much needed position from which to argue the necessity for reform and development.

So much is said about feedback being either positive or negative. In the social world, positive feedback is seen as the 'encourager' and negative feedback as the 'discourager'. So often we read or hear in the context of teaching that students should be given positive feedback to help them learn. I find myself reflecting on the engineering control systems concepts of positive and negative feedback where negative feedback is used to keep a system under control and to correct deviations from the desired outcome, whereas positive feedback leads either to instability and lack of control or to a function like a snap action switch where there are only two possible states or positions. When there is an established picture of what the different aspects of what a learning environment should 'look like' and this is communicated to those who are involved in the feedback process as goals, then feedback is a powerful tool in the process of worthwhile reform. From the 'social' perspective, negative feedback can be argued to be damaging to the process of improvement, yet positive feedback can only encourage what students want without a relevance to the goals being necessary. From the 'control systems' perspective, negative feedback compares the actual happenings with the desired goals and provides the information to remedy the differences. Without a goal, feedback in the form of reflection or in concrete data that is necessary for closing the gap between the 'actual' and the 'goal' is questionable, if not impossible.

Implications of the Theoretical Model

The theoretical model presents many of the groups of data that input into the learning environment. While some of the data groups are directive in nature and others are suggestive in nature, some can contradict each other and others unreachable, they all combine to create goals and objectives for the process of learning about the students' learning process. Because the philosophy of social intercourse will always be a mixture of conflict and agreement, the application of the theoretical model should be to stimulate the process of reflection and experimentation in the pursuit of improving the facilitation of learning. In this way, a picture of the ideal theoretical and workable environment can be visualised and a goal can be established. This in turn will stimulate the process of reflection, experimentation and learning.

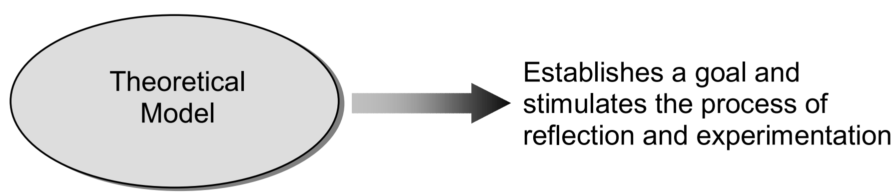

Figure 6.5. The purpose of the theoretical model

Student feedback of the learning/assessment environment

Although the student feedback of the learning/assessment environment produced many thoughts about improvement, the key is to implement the negative thoughts in a positive way. In this study, the student questionnaire and interview focused on a certain aspect of the whole picture and was more reflective on what the students experienced during the first few weeks of the course. Their measuring point or goal would have been influenced both by acceptance of what I promoted as being my expectations of them and what had evolved as their standard during their prior learning experiences.

Students' comments produce both positive comments and negative comments. Positive comments are encouraging, but they should not be allowed to influence the 'control' of the direction of a process of change. Focusing only on what seems to be 'good' to the detriment of what needs to be 'changed' will eventually lead to the 'instability' of that process of change. Negative comments are usually discouraging, but when they are allowed to influence the direction of a process of change, the change will be towards an improvement in the system in meeting the objectives. Reflecting on negative comments from students and then using those thoughts to improve the learning environment is the positive side of negative feedback. Thus student feedback can stimulate the process of reflection and improvement.

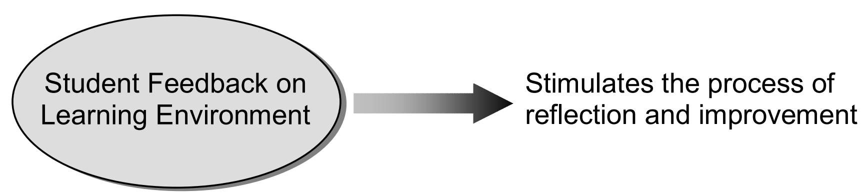

Figure 6.6. The purpose of student feedback

Student perception of the importance of skills

The students' ratings of the list of employability skills are neither correct nor incorrect but rather the opportunity to ponder the values that students have. Such a reflection does not have much value unless these values are compared to an established goal, which in this case, can be established from the desired attributes from prospective employers. Other inputs for these desired attributes can also be derived from established registration bodies that register Engineering Technicians. Once a clear set of attributes is established, these should be seen as outcomes of the programme of study against which the graduate can be measured or assessed. The process of determining whether a graduate reaches these attributes is a process that is virtually totally outside of the control and determination of the teacher in the classroom. In this study, the prospective employers perception of the importance of skills could at this stage be considered the ideal outcome or goal. The student perception of the importance of skills can be then compared to those of the prospective employers and the result seen as a focus for consideration in further development of the learning environment. Because the student and employer survey occurred during the delivery of the working model associated with this study, I took the 'risk' of introducing a greater emphasis on the development of these non-academic skills while 'standing' on previous research and academic readings. A knowledge of the prospective employers' needs and a knowledge of how students perceive these same skills, will stimulate the process of developing these essential non-academic skills.

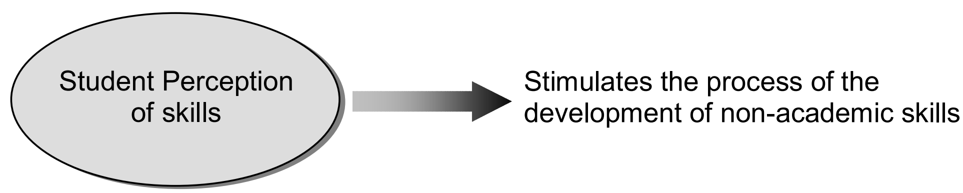

Figure 6.7. The purpose of student perception of non-academic skills

Reliability of the assessment scoring rubric

The scoring rubric was introduced into the learning environment as outlined in the working model without any prior experience. It was during the recess over the Christmas period that I 'came across' the concept during research reading and the idea captured my imagination as a tool that could be used to facilitate the dual assessment difficulty. The development quickly followed and it was introduced into the learning environment without any trialling or discussion with another teacher. Support for using a rubric has been supplied by feedback from students, the ease of which I was able to score or check-score assessment material, the lack of students quibbling over why someone else received ½ a mark more for what to them was the same work and the ability to quickly produce a mark with more meaningful feedback, has been further supported by the reliability to produce a mark which is compatible with that produced by comparison with the traditional marking schedule. These findings would support the argument that there is no reason why the use of a marking/scoring rubric cannot be further promoted as a very useful tool in a teacher's toolbox.

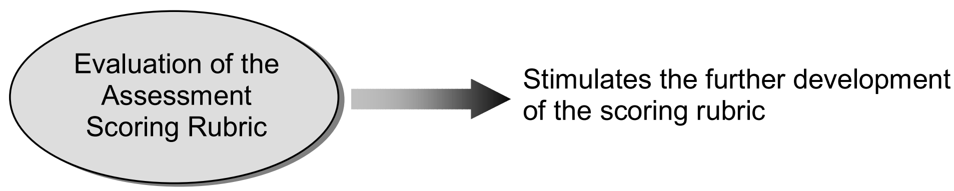

Figure 6.8. The evaluation of the assessment scoring rubric

Teacher's perception of the learning/assessment environment

What I have written in this summary complements what I wrote in the previous section regarding my perception of the learning and assessment environment. I can only reiterate that the process of learning alongside the students was a challenging and enjoyable experience.

So often the focus in a learning environment is on what the student can learn from the teacher and seldom do we hear about what a teacher can learn from the students. I believe that through the process of the exercise outlined in this thesis, I have gained much knowledge from the students.

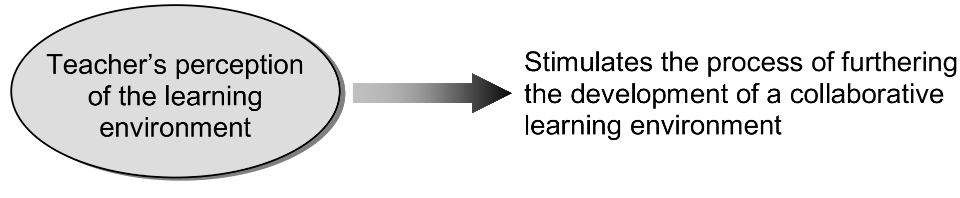

Figure 6.9. Teacher perception of the learning environment.

Putting the parts together

My perception of the learning environment is important, as it now becomes another part of the reflective nature of the experience, reflection and experiential nature of a teacher's life. Each of these pictures are part of the overall nature of recognising that we always have room to improve, that there is always more to learn and that our focus brings great rewards when it is on others and not on ourselves.

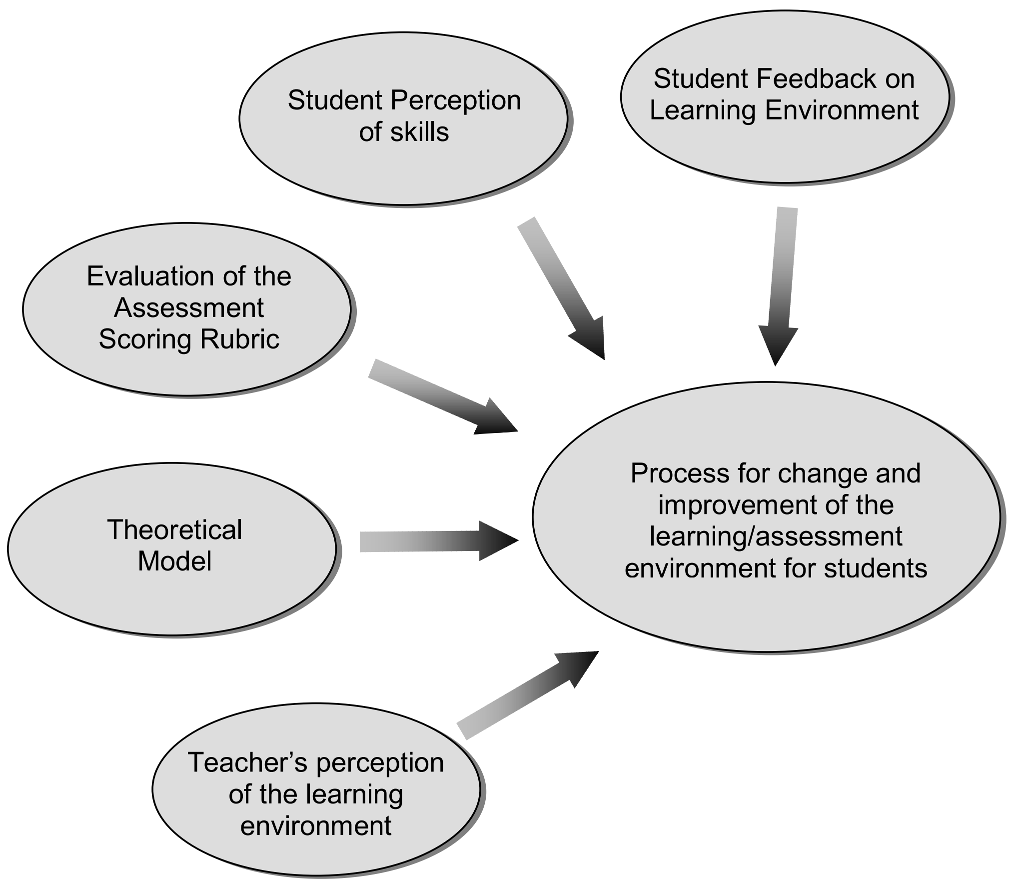

Figure 6.10. Conceptualising the data of goals and feedback to stimulate the process of constructive improvement of a student's learning environment

CHAPTER 7

REFLECTIONS AND CONCLUSION

7.1 INTRODUCTION

This thesis is a record of a case study that presents an overview of the principles, innovations, thoughts and results of a period of my life during which I sought an answer or way of resolving a problem with assessment requirements. I have presented a background summary of the events and developments that led to the initial focus for the study in Chapter 1, literature that presents a kaleidoscope of information in Chapter 2, and an overview of the research methodologies used in this study in Chapter 3. Chapter 4 outlined a theoretical model of the learning environment based on research literature, while Chapter 5 introduced a practical model of the learning environment developed and used for two of the four courses. A summary of some of the findings from that semester has been presented in Chapter 6.

In Section 7.2, I begin my reflections and conclusions by discussing some thoughts on the study, then in Section 7.3, I offer suggestions for further research based on reflections from the study. I conclude the thesis with some personal reflections in Section 7.4.

7.2 REFLECTIONS ON THE STUDY

This study started with the desire and a resolve to find a way of how to simultaneously assess students for two diplomas, one requiring competency-based assessment and the other, achievement-based assessment. Because this desire and resolve was in essence the trigger for a journey of discovery, the journey did not start with a list of research questions that demanded an answer, but rather started with the recognition of three important concepts. I needed to focus on the student and find an answer that will assist them in their journey of learning, I had to recognise again that I did not have the knowledge of how to facilitate this need, and most importantly that

I needed to remind myself to operate in humility, giving away any pride, power and control. Pride would get in the way of acknowledging that I did not know how to do the dual assessment and that I needed to learn, and power and control would get in the way of facilitating a learning environment where the students themselves learn how to learn. This does not mean that my class would make all the rules and would dictate all the class's direction, but it does mean that it would make it a more co-operative venture. I needed to be alert to difficulties that are rooted in educational wounding and enjoy the delights of seeing students grow in both skill and confidence (Pedder, 2000).

The journey continued with the research into literature in an attempt to find answers to the problem. Although a specific answer was not found in the literature, an immense amount of literature on a range of associated material was found or discovered. This led to the decision to take a risk of being disciplined by management by implementing some non-traditional approaches to the learning environment, a risk perceived by me based on previous experiences of being disciplined after introducing innovative changes into the learning environment. In this case, I took responsibility for my own actions (McNiff, Lomax, & Whitehead, 1996) and followed my inner resolve to find an answer and make it work for that semester, not knowing that it was to be the last semester that I would teach. There was no clearly definable order in which I approached the development of the working model for that semester, rather it was a case of finding that after two months of intense research, reading, contemplating and developing of material over the Christmas period, it came together ready to start the new semester. While the basic groundwork or framework had been developed ready for the start of the semester, writing of laboratory material and tests based on previous material but with new layouts and content, continued well into the semester. The end of the semester approached with the knowledge that in a few weeks time, two more courses would start and all the laboratory and test documentation for those courses also needed to be written. Yet I do not remember any anxiety about that, there was more a sense of 'this is working and next year I will be able to refine those areas needing attention as the basic preparation has been done'.

I say that this was a journey of discovery because in not having any specific questions to test, I did not know where this journey would take me. In fact, the writing of this thesis has been not so much a writing of the journey as it happened, but rather a documentation of reflection. For example, the theoretical model was not compiled before the evolution of the working model because at that time it was simply a lot of information that was being absorbed through reading and the pressure of time did not allow it. The model has been compiled by going back over all the documentation that I had gathered and using the grounded-theory methodology to compile a vast amount of data into a more understandable model, a model that I believe supported my original instinct based on the literature. The compilation of the model was to me both a laborious and a most enlightening exercise. It is almost a case of 'now I am beginning to understand'. The survey of prospective employers was another example where the concepts involved in the working model of encouraging the development of skills other than academic theory, were put in place before the confirmation gained from the actual survey. The survey was completed in the second semester after the first semester trial of assessment through the working model. Hence the survey confirmed the data in literature that had been reviewed at the beginning of the year.

The distinctiveness of the study is due to the rather unique problem of having the responsibility of organising and implementing the simultaneous dual assessment in a particular engineering discipline. However, the contributions of the study can be focused on supporting the generalised concept that for every teacher or teacher-to-be, no matter what academic level or discipline they may be considering or find themselves teaching, no matter how many years they have been teaching, there are three on-going principles: the focus is to be on assisting each student towards their goal in a manner that is effective for them, the acknowledgment that our 'teaching' can always be improved, and that pride, power and control can get in the way of meaningful and collaborative learning. Because professional development of colleagues is seen as one of the main contributions of case studies and action research studies to the real world of others (Cohen & Manion, 1994), any constraints and limitations of this study would be minimised through the acceptance that what I have shared, could assist in the growth of a colleague.

7.3 REFLECTIONS FROM THE STUDY

Besides the many reflections prompted by this study are reflections on further research. These reflections have been categorised as research into the professional development of tertiary teachers and research into the learning environment and assessment.

Research to the professional development of tertiary teachers

In the Tertiary education strategy: 2007-12, the Hon Michael Cullen, (Minister for Tertiary Education), on behalf of the New Zealand government writes "This Strategy provides a clear statement of the government's expectations and priorities, it confirms the government's commitment to a broad and inclusive tertiary education system, and it sets out the specific focus that tertiary education organizations need to have on the aspirations of Maōri and Pasifika peoples" (Office Of The Minister For Tertiary Education, n.d., p. 2.) Further in this document the strategy presents "To support a shift in focus giving more attention to quality teaching and learning which is relevant to the needs of students, the economy and society, the government is changing its system for tertiary education funding" (p. 6.). It continues to state "Over the next five to ten years we need to: … "increase the number of New Zealanders achieving qualifications at higher levels (e.g., trades training, diploma, degree and postgraduate education)" … "reduce skills shortages through improving the relevance of tertiary education to the needs of the labour market" … and "continue to build the excellence of tertiary research".

Further in the document under the heading of "Ensuring Maximum Educational Opportunity for All New Zealanders" we read "Educational opportunity is about both equity of access and achievement. Currently, we know that there are areas of disparity in both access and achievement for some groups of New Zealanders.

Tertiary education organisations need to identify, understand and respond to the diverse needs of their local communities. This will take a more sophisticated approach to ensuring an equitable, responsive tertiary education system. Ensuring maximum education opportunities for all New Zealanders is not just about lifting the participation rates of underrepresented groups. It is also about ensuring that the spread of achievement across levels of study and discipline areas supports all New Zealanders to fully participate in economic, social and cultural life" (Office Of The Minister For Tertiary Education, n.d., p. 21.).

So much has been and continues to be written on skills training and on the need for employers to continuously promote and encourage skills updates for staff. The question then needs to be asked, 'What provision is there to update skills of teachers in tertiary education'? This is especially so when one considers that tertiary teachers are often appointed on the basis of their professional experience and not on ability to teach. Is the new Tertiary Education Strategy going to pave the way for a change in tertiary education where the professional doer becomes more like a professional teacher who has expertise in their chosen profession (Redish, 1996)? If as Hargreaves (1997) writes that assessment methods are pivotal in the development of students' learning strategies, that teaching, learning and assessment are inextricably linked, and that innovative assessment is critical in upholding the role of educational institutions as providers of an holistic learning experience, then skills training is required for tertiary teachers. These skills should include both educational practice and assessment principles.

A communities of practice framework for supporting tertiary teachers' workplace learning is presented in 'Becoming a tertiary teacher: learning in communities of practice' (Viskovic, 2006). This has the makings of a sound principle but only if provision is made to bring fresh and innovative ideas into those communities. If the community is composed of what could be considered to be traditional teachers, i.e. those who probably not have undergone the long process of socialisation into academic norms (Mutch, 2002) and/or those who are not teachers, they are what they have been trained to be (Redish, 1996), then the prevailing concept of teaching will likely be that which these people learnt during their student days and more likely than not, it will be the 'bad' principles they will remember. Such bad principles will only be reversed by the introduction of fresh, new and innovative teaching practices.

Suggested Research #1

What support is there in these communities of learning and in teacher training in tertiary institutions to foster innovative learning environments for students, authentic assessment and assessment for learning rather than assessment of learning.

Research into assessment

There has been a lot of diverse literature on achievement-based assessment, on competency-based assessment and the pros and cons of each. New Zealand introduced the NCEA qualification based mainly on achievement standards which although primarily competency-based, recognise credit for achievement as well. There has been discussion and literature on the concept of grading of competency-based assessment and the pursuing discussions have been described as a vexed issue of grading (National Centre for Vocational Education Research, 2001c). Although some researchers have suggested that grading and competency-based assessment is not compatible, other researchers believe that grading can be wholly compatible with a competency-based approach to assessment (National Centre for Vocational Education Research, 2001c).

Items through the media and through personal contacts have highlighted some of the perceived problems with different forms of assessment. For example, does an examination on its own mean much because I once had a student who was a strong adherent of a religious faith that emphasizes memorisation and not to question. He was able to memorise how to calculate a solution to a circuit analysis problem, yet if the same circuit was completely redrawn, he lacked the analytical skills to be able to recognise the circuit and was unable to complete the analysis. He also had great difficulty doing laboratory exercises because he had trouble trying to analyse a problem and test a circuit. Yet he passed the examination-based course probably through his ability to memorise facts and methods and not by his ability to apply knowledge. The NCEA has provoked more discussion this year primarily through the argument that it does not challenge students to work hard nor do the results with graded competency grades mean much to parents and students. The argument that was presented was that there was no mark to gauge a student's ability. Consequently some schools promoted the Cambridge International Examination as a more meaningful alternative to the NCEA. Other contacts I have, have described NCEA students who only work enough throughout the year to get a competency credit, in effect coasting through the course and not extending themselves.

One of the reflections from this study is that there is literature on competency-based assessment, achievement-based assessment, and graded competency-based assessment or the use of achievement standards, but not achievement-based grading which incorporates competency-based standards throughout the course of learning and includes authentic assessment that can also be graded for achievement. I did not find any literature of this concept throughout the course of this study yet I propose that such an approach may provide an answer to some of the problems. The concept is in effect based on the outcomes of this study.

Suggested Research #2

Undertake a feasibility study to determine the viability of a framework of learning based on accumulative grading of authentic assessment to provide an achievement grade at the end of the course and incorporating competency-based assessment to provide the groundwork of a minimum competency grade for each section of the prescription or objective.

7.4 CONCLUDING REMARKS

In essence, the material presented in this thesis speaks for itself and I make no attempt to either justify any misgivings or to take any credit. The semester through which I facilitated the learning/assessment environment is seen through reflection as being one of the most enjoyable times of my career. I had taken the risk of upsetting students and management, implemented changes that I believed would benefit students, dealt with the impact of outside directions from institutional administration and 'government' bodies and created an environment where both the students and myself could work together in collaborative learning. Those classes are remembered with much pleasure. Unfortunately those times were cut short as my wife moved into the final stages of terminal cancer and I took time out to care for her. Upon her death I followed medical advice and subsequently retired. My only regret is that the desire that blossomed at that time to further the process of taking the learning environment for my students down the exciting path of discovery and innovation remains unfulfilled. Nevertheless, at the end of that semester and before the knowledge of the impending change in my lifestyle, I facilitated an official institute Student Evaluation of Teaching for the students to complete on my teaching. What better gift could a teacher (tutor) be given than the comment "The best tutor I have ever had".

REFERENCES

Aldridge, M. D., & Benefield, L. D. (1998). Assessing a specific program. In *How do you measure success? Designing effective processes for assessing engineering education* (pp. 27-34). Washington: American Society for Engineering Education.

American Association for Higher Education (AAHE) (n.d.). 9 principles of good practice for assessing student learning. In *How do you measure success? Designing effective processes for assessing engineering education*: American Society for Engineering Education.

American Federation of Teachers. (n.d.). *Employability skills not enough*. Retrieved 17/12/2002, from http:/www.aft.org/nextstep/page23.htm

American Youth Policy Forum. (2003). *Essentials of high school reform: New forms of assessment and contextual teaching and learning*. Washington, D.C.: American Youth Policy Forum.

Amos, S. J. (1998). *Assessment techniques for industry desired competencies in construction education*. Retrieved 2/12/2002, from http://www.asee.org/conferences/98conf/00032.pdf

Andrade, H. G. (2000). Using rubrics to promote thinking and learning. *Educational Leadership, 57* (5), 13-19.

Angelo, T. A., & Cross, K. P. (1988). *Classroom assessment techniques: A handbook for college teachers* (2nd ed.). San Francisco: Jossey-Bass Inc.

Assessment Reform Group. (2002). *Assessment for learning: Research-based principles to guide classroom practice*. Retrieved 24/6/2006, from http://www.aaia.org.uk/pdf/AFL_10principlesARG.pdf

Barker, A. (1995). Standards-based assessment: the vision and broader factors. In R. Peddie & B. Tuck (Eds.), *Setting the standards: Issues in assessment for national qualifications*. Palmerston North: The Dunmore Press Ltd.

Bassey, M. (1999). *Case study research in educational settings*. Buckingham: Open University Press.

Beder, S. (2000, March). Valuable skills learned from "basket-weaving". *Engineers Australia,* p. 46.

Berglund, A., Daniels, M., Hedenborg, M., & Tengstrand, A. (1998). Assessment to increase students' creativity: Two case studies. *European Journal of Engineering Education, 23*(1), 45-54.

Besterfield-Sacre, M., Shuman, L. J., Wolfe, H., Atman, C. J., McGourty, J., Millar, R. L., et al. (2000). Defining the outcomes: A framework for EC2000. *IEEE Transactions On Education, 43*(2), 100-110.

Birenbaum, M. (1997). Assessment preferences and their relationship to learning strategies and orientations. *Higher Education - Dordrecht, 33*(1), 71-84.

Black, P., & Wiliam, D. (1998). *Inside the black box: Raising standards through classroom assessment*. Retrieved 13 June 2006, from http://www.pdkintl.org/kappan/kbla9810.htm

Blaxter, L., Hughes, C., & Tight, M. (1996). *How to research*. Buckingham: Open University Press.

Bloom, B. (1956). *Bloom's taxonomy of educational objectives*, 2003, from http://faculty.washington.edu/krumme/guides/bloom.html

Boaler, J. (2003). When learning no longer matters: Standardized testing and the creation of inequality. *Phi Delta Kappan, 84* (7), 502.

Boog, B. W. M. (2003). The emancipatory character of action research, its history and the present state of the art. *Journal of Community & Applied Social Psychology, 13*, 426–438.

Booth, R. (2000). *Competency based assessment - One minute wonder or here to stay? Practioners' attitudes to competency based assessment and the complexities of implementation.* Retrieved 11/12/2002, from http://www.awetra.org.au/papers%202000/booth.pdf

Boud, D. (1995). *Enhancing learning through self assessment*. London: Kogan Page Limited.

Brookfield, S. D. (1986). *Understanding and facilitating adult learning*. Milton Keynes: Open University Press.

Brookhart, S. M. (1999). The art and science of classroom assessment: The missing part of pedagogy. *ASHE-ERIC Higher Education Report, 27*(1).

Brookhart, S. M. (2001). Successful students' formative and summative uses of assessment information. *Assessment in Education - Principles Policy and Practice, 8*(2), 153-169.

Brown, G., Bull, J., & Pendlebury, M. (1997). *Assessing student learning in higher education*. London: Routledge.

Brualdi, A. (1998). Implementing performance assessment in the classroom. *Practical Assessment, Research & Evaluation*, 6(2). Retrieved May 13, 2004 from http://PAREonline.net/getvn.asp?v=6&n=2

Campbell, J. O., Bourne, J. R., Mosterman, P. J., & Brodersen, A. J. (2002). The effectiveness of learning simulations for electronic laboratories. *Journal of Engineering Education, January*, 81-87.

Carroll, A., & McCrackin, J. (1998). The competent use of competency-based strategies and development. *Performance Improvement Quarterly, 11*(3).

Chittenen, E. (1991). Authentic assessment, evaluation and documentation of student performance. In V. Perrone (Ed.), *Expanding student assessment* (pp. 22-31): Association For Supervision and Curriculum Development.

Cohen, L., & Manion, L. (1994). *Research methods in education* (4th ed.). London: Routledge.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). New York: RoutledgeFalmer.

Colby, S. A. (1999). Grading in a standards-based system. *Educational Leadership, 56*(6), 52.

Conrad, C. F. (1979). A grounded theory of academic change. *Sociology of Education, 51*, 101-112.

Corbin, J., & Strauss, A. (1990). Grounded Theory Research: Procedures, Canons, and Evaluative Criteria. *Qualitative Sociology, 13*(1), 3-21.

Corder, N. (2002). *Learning to teach adults*. New York: Routledge.

Curtis, D., & McKenzie, P. (2001). *Employability skills for Australian industry: literature review and framework development*: Australian Council for Educational Research.

Dawson, C. (2002). *Practical research methods: A user-friendly guide to mastering research techniques and projects*. Oxford: How To Books Ltd.

de Vaus, D. (2002). Survey research. In T. Greenfield (Ed.), *Research methods for postgraduates*. London: Arnold.

Dekker, C. (1994). *The New Zealand guide to transferable skills*. Auckland: Random House New Zealand Ltd.

Denscombe, M. (2003). *The Good Research Guide: For Small-Scale Social Research Projects* (2nd ed.). Maidenhead - Philadelphia: Open University Press.

Department of Education Training and Youth Affairs. (2000). *Employer satisfaction with graduate skills*: Commonwealth of Australia.

Department of Employment Education Training and Youth Affairs. (1998). *Skills in Australia - Trends and shortages*. Canberra: Australian Government Publishing Service.

Dunn, L., Parry, S., & Morgan, C. (2002). *Seeking quality in criterion referenced assessment.* Paper presented at the Learning Communities and Assessment Cultures Conference, University of Northumbria.

Elliot, S. N. (1995). *Creating meaningful performance assessments. ERIC Digest E531*. Retrieved 8/12/2002, from http://www.ed.gov/databases/ERIC_Digests/ed381985.html

Engineering Council. (2004). *UK Standard for Professional Engineering Competence: Engineering Technician Standard*. Retrieved 3 June 2006, from http://www.engc.org.uk/UKSPEC/ukspec_standards.aspx

ETITO. *ElectroTechnology Industry Training Organisation*, from http://www.etito.co.nz/

Faculty of Applied Technology. (2002). *Diploma in Technology Curriculum Document*: MY Institute of Technology.

Feisel. (1998). Accepting the challenge. In *How do you measure success? Designing effective processes for assessing engineering education* (pp. 65-66). Washington: American Society for Engineering Education.

Fischer, C., & King, R. (1995). *Authentic assessment: A guide to implementation*. Thousand Oaks, California: Corwin Press, Inc.

Fraser, B. J. (1996). *Long-standing problems and recent developments in assessment and evaluation in Science and Mathematics.* Paper presented at the Seminar on Assessment and Evaluation in Science and Mathematics: Innovative Approaches, Universiti Brunei Darussalam.

Fraser, B. J. (1998). Science learning environments: Assessment, effects and determinants. In B. J. Fraser & K. G. Tobin (Eds.), *International Handbook of Science Education* (pp. 527-564). Great Britain: Kluwer Academic Publishers.

Fraser, B. J., Giddings, G. J., & McRobbie, C. J. (1992). *Assessing the climate of science laboratory classes*. Perth: Curtin University of Technology.

Fraser, S., & Cheers, M. (2000). What does tertiary teaching need: Visionaries or pragmatists? In A. Herrmann & M. M. Kulski (Eds.), *Flexible Futures in Tertiary Teaching*: Proceedings of the 9th Annual Teaching Learning Forum, 2-4 February 2000. Perth: Curtin University of Technology.

Freeman, R., & Lewis, R. (1998). *Planning and implementing assessment*. London: Kogan Page.

Gandal, M., & Vranek, J. (2001). Standards: Here today, here tomorrow. *Educational Leadership, 59*(1), 5-13.

Gardner, E. (1989). *Five common misuses of tests. ERIC Digest No. 108*. Retrieved 1/12/02, from http://www.ed.gov/databases/ERIC_Digests/ed315429.html

Gay, L., & Airasian, P. (2000). *Educational research: Competencies for analysis and application*. Upper Saddle River, NJ: Prentice-Hall, Inc.

Gfroerer, M. (2000). Career guidance on the cutting edge of competency-based assessment. *Journal of Career Development, 27*(2), 119-131.

Gibbs, G., Rust, C., Jenkins, A., & Jaques, D. (1994). *Developing student's transferable skills*. Oxford: The Oxford Centre For Staff Development.

Gipps, C. (1990). *Assessment: A teachers' guide to the issues*. Sevenoaks, Kent: Hodder and Stoughton Educational.

Gipps, C. (1994). *Beyond testing: Towards a theory of educational assessment*. London: The Falmer Press.

Gipps, C., & Murphy, P. (1994). *A fair test? Assessment, achievement and equity*. Buckingham: Open University Press.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. New York: Aldine de Gruyter.

Gokhale, A. A. (1995). Collaborative learning enhances critical thinking. *Journal of Technology Education, 7*(1).

Goleman, D. (1998). *Working with emotional intelligence*. London: Bloomsbury Publishing Pic.

Goulding, C. (2000). Grounded Theory Methodology and Consumer Behaviour, Procedures, Practice and Pitfalls. *Advances in Consumer Research, 27*(1), 261-266.

Greer, L. (2001). Does Changing the Method of Assessment of a Module Improve the Performance of a Student. *Assessment & Evaluation in Higher Education, 26*(2), 127-138.

Gupta, M. L. (2004). Enhancing student performance through cooperative learning in physical sciences. *Assessment and Evaluation in Higher Education, 29*(1).

Hafner, J., & Hafner, P. (2003). Quantitative analysis of the rubric as an assessment tool: An empirical study of student peer-group rating. *International Journal of Science Education, 25*(12), 1509-1528.

Hargreaves, D. J. (1997). Student learning and assessment are inextricably linked. *European Journal of Engineering Education, 22*(4), 401-409.

Higuchi, C. (1993). *Performance-based assessments and what teachers need*. Los Angeles: National Centre for Research on Evaluation, Standards and Student Testing.

Hinett, K., & Thomas, J. (1999). Thinking about self-assessment, reflection and understanding. In K. Hinett & J. Thomas (Eds.), *Staff guide to self and peer assessment* (pp. 6-22). Oxford: The Oxford Centre For Staff And Learning Development.

Hirsch, D. (2000). Practitioners as Researchers: Bridging Theory and Practice. *New Directions for Higher Education* (110), 99-106.

Hughes, M. (2002). Interviewing. In T. Greenfield (Ed.), *Research methods for postgraduates*. London: Arnold.

Human Resources and Skills Development Canada. (2003). *Essential skills*. Retrieved 13 June 2006, from http://srv600.hrdc-drhc.gc.ca/esrp/english/general/home_e.shtml

Institution of Engineers of Ireland. (2002). *International recognition for technicians takes quantum leap forward*. Retrieved 9 April 2004, from http://www.cttam.com/Archives/TechLink/techlink-summer-2002.html#International%20Recognition

Jarvis, P. (1999). *The practitioner-researcher: Developing theory from practice*. San Fransico: Jossey-Bass Publishers.

Jennings, L. (2002). *A comparison of a traditional laboratory versus a computer simulated laboratory*. Auckland: Department of Electrical and Electronic Engineering, Manukau Institute of Technology.

Johnson, A. P. (2005). *A short guide to action research* (2nd ed.). Boston: Pearson Education, Inc.

Kearns, P. (2001). *Review of research: generic skills for the new economy*. Leabrook SA: NCVER Ltd.

Kerka, S. (1995). *Techniques for authentic assessment. Practice application brief*. Columbus: ERIC Clearinghouse on Adult, Career, and Vocational Education.

Kerka, S. (1998). *Competency-Based Education and Training: Myths and Realities*. Retrieved 26 August 2006, from http://www.cete.org/acve/docgen.asp?tbl=mr&ID=65

Kerr, M. (2002). Workplace learning - a natural way to learn. In *Voices | He Reo: New directions in workplace learning* (pp. 6-7). Wellington: Skill New Zealand.

Khambadkone, A. (2001). *Assessment towards in-depth and student centered learning.* Paper presented at the International Conference on Engineering Education, Oslo, Norway.

Kizlik, B. (2003). *Examples of behavioral verbs and student activities*. Retrieved 9/4/2004, from http://www.adprima.com/examples.htm

Kizlik, B. (2004a). *A rationale for behavioral objectives*. Retrieved 9/4/2004, from http://www.adprima.com/objectives2.htm

Kizlik, B. (2004b). *Definitions of behavioral verbs for learning objectives*. Retrieved 9/4/2004, from http://www.adprima.com/verbs.htm

Kizlik, B. (2004c). *How to write effective behavioral objectives*. Retrieved 9/4/2004, from http://www.adprima.com/objectives.htm

Kizlik, B. (2004d). *How to write an assessment based on an objective*. Retrieved 9/04/2004, from http://www.adprima.com/assessment.htm

Knapper, C. K., & Cropley, A. J. (2000). *Lifelong learning in higher education* (3rd ed.). London: Kogan Page Limited.

Kozma, R. B. (1985). A grounded theory of instructional innovation in higher education. *The Journal of Higher Education, 56*(3), 300-319.

Kuhne, G. W., & Quigley, B. A. (1997). Understanding and Using Action Research in Practice Settings. *New Directions for Adult and Continuing Education* (73), 23-40.

Kyle, W. C. (1997). Assessing student's understandings of science. *Journal of Research in Science Teaching, 34*, 851-852.

La Marca, P. M. (2001). *Alignment of standards and assessments as an accountability criterion. ERIC Digest*. Retrieved 1/12/2002, from http://www.ed.gov/databases/ERIC_Digests/ed458288.html

Lankard, B. A. (1990). Employability--the fifth basic skill. *ERIC Digest No. 104. Columbus: Centre on Education and Training for Employment. The Ohio State University. (ED 325 659)*.

Lankard, B. A. (1996). *Job training versus career development: What is Voc Ed's role?* Retrieved 7/12/2002, from http://www.ericacve.org/docgen.asp?tbl=archive&ID=A010

Leach, L., Neutze, G., & Zepke, N. (2001). Assessment and empowerment: some critical questions. *Assessment and Evaluation in Higher Education, 26*(4), 293-305.

Limage, L. (1993). Adult literacy and basic education in Europe and North America. In R. Edwards, S. Sieminski & D. Zeldin (Eds.), *Adult learners, education and training*. London: Routledge.

Locke, K. (2001). *Grounded Theory in Management Research*. London: Sage.

Maharey, S. (2001). *Skills for a knowledge economy: A review of industry training in New Zealand*: Office of the Associate Minister of Education (Tertiary Education).

Maharey, S. (2002). Prestige learning pathways. In *Voices | He Reo: New directions in workplace learning* (pp. 4-5). Wellington: Skill New Zealand.

Maki, P. L. (2004). Developing an assessment plan to learn about student learning. In P. Hernon & R. E. Dugan (Eds.), *Outcomes assessment in higher education: Views and perspectives*. Westport: Libraries Unlimited.

Mamchur, C. (1992). But...the curriculum. In K. Burke (Ed.), *Authentic assessment* (pp. 123-132). Australia: Hawker Brownlow Education.

Marton, F., & Ramsden, P. (1988). What does it take to improve learning? In P. Ramsden (Ed.), *Improving Learning, New Perspectives*. London: Kogan Page.

Marzano, R. J. (1996). Eight questions about implementing standards-based education. *Practical Assessment, Research & Evaluation, 5*(6).

Marzano, R. J. (2000). *Transforming classroom grading*. Virginia, USA: Association for Supervision and Curriculum Development.

McLaughlin, M. (1995). *Employability skills profile: What are employers looking for?* Retrieved 7/12/2002, from http://www.ed.gov/databases/ERIC_Digests/ed399484.html

McNiff, J., Lomax, P., & Whitehead, J. (1996). *Your and your action research project*. London: Routledge.

McTighe, J. (1996). What happens between assessments? *Educational Leadership, 54*(4).

Miller, K., & Rutherford, P. D. (1996a). Principles and processes of assessment. In *Competency-based assessment: The assessor's guide. New Zealand Edition*. South Melbourne: Pitman Publishing.

Miller, K., & Rutherford, P. D. (1996b). Assessment in practice. In *Competency-based assessment: The assessor's guide. New Zealand Edition*. South Melbourne: Pitman Publishing.

Ministry of Education. (1997). National Qualifications Framework: Green Paper.

Ministry of Education. (2002b). *Tertiary Education Strategy*. Wellington: Ministry of Education.

Moore, D. S., & McCabe, G. P. (1989). *Introduction to the practice of statistics*. New York: W. H. Freeman and Company.

Moskal, B. M. (2000). Scoring rubrics: what, when and how? *Practical Assessment, Research & Evaluation, 7*(3).

Moskal, B. M. (2003). Recommendations for developing classroom performance assessments and scoring rubrics. *Practical Assessment, Research & Evaluation, 8*(14).

Moskal, B. M., & Leydens, J. A. (2000). Scoring rubric development: Validity and reliability. *Practical Assessment, Research & Evaluation, 7*(10).

Moskal, B. M., Leydens, J. A., & Pavelich, M. J. (2002). Validity, reliability and the assessment of engineering education. *Journal of Engineering Education, 91*(3), 354.

Mutch, A. (2002). Thinking Strategically about Assessment. *Assessment & Evaluation in Higher Education, 27*(2), 163-174.

Nataraj, M., & McManis, K. (2001). *Application of educational and engineering research to classroom teaching.* Paper presented at the International Conference on Engineering Education, Oslo, Norway.

National Centre for Vocational Education Research. (2000, December 2). UK skills shift from manual focus. *Insight*, 6.

National Centre for Vocational Education Research (2001a, August 4). Generic skills for the new economy. *Insight*, 3.

National Centre for Vocational Education Research. (2001b, August 4). Language and literacy - the essential skills. *Insight*, 6.

National Centre for Vocational Education Research. (2001c, December 5). Making assessment better. *Insight*, 6.

National Centre for Vocational Education Research. (2002, October 8). New analysis of graded assessment. *Insight*, 3.

NCEA. *National Certificate of Educational Achievement*, from http://www.nzqa.govt.nz/ncea/

New Zealand Qualifications Authority. (1997). *To your marks! Advice to teachers and tutors on setting and marking assessments*. Wellington: New Zealand Qualifications Authority.

New Zealand Qualifications Authority. (2000). *Best practice in the assessment of unit standards*. Retrieved 15/05/2003, from http://www.nzqa.govt.nz/framework/about/bestpractice.pdf

New Zealand Qualifications Authority. (2001). *Learning and assessment: A guide to assessment for the national qualifications framework*. Wellington: New Zealand Qualifications Authority.

New Zealand Qualifications Authority. (2005). *Best practice principles for the assessment of unit standards*. Retrieved 1/9/2006, from http://www.nzqa.govt.nz/for-providers/resources/bestpract-us.html

Nightingale, P., TeWiata, I., Toohey, S., Hughes, C., Ryan, G., & Magin, D. (1995). A resource for improving the practice of assessment in higher education. *Innovations in Education and Training International, 32*(4), 344-355.

OECD. (1999). *Measuring student knowledge and skills: A new framework for assessment*. Paris: OECD Publications.

Office of Instructional Resources. (1979). *Assigning course grades.* Champaign: University of Illinois at Urbana-Champain.

Ontario Ministry of Education. (2001). *You and the job market*. Ontario: Queen's Printer for Ontario.

Ory, J., & Ryan, K. (1993). *Tips for improving testing and grading*. Newbury Park: Sage.

Overtoom, C. (2000). *Employability skills: An update. ERIC Digest No. 220*. Retrieved 1/12/2002, from http://www.ed.gov/databases/ERIC_Digests/ed458288.html

Pandey, T. (1990). *Authentic mathematics assessment. ERIC/TM Digest.* Retrieved 7/12/02, from http://www.ed.gov/databases/ERIC_Digests/ed354245.html

Pandit, N. R. (1996). The creation of theory: A recent application of the grounded theory method. *The Qualitative Report, 2*(4).

Parker, L. H., & Rennie, L. J. (1998). Equitable assessment strategies. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education* (pp. 897-910). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Pearson Education Development Group. (n.d.). *Authentic assessment overview*. Retrieved 8/12/2002, from http://www.teachervision.com/lesson-plans/lesson-4911.html

Peddie, R. (1992). *Beyond the norm? An introduction to standards-based assessment.* Wellington: New Zealand Qualifications Authority.

Peddie, R. (1995). Competency, standards, merit and excellence. In R. Peddie & B. Tuck (Eds.), *Setting the standards: Issues in assessment for national qualifications*. Palmerston North: The Dunmore Press Ltd.

Pendley, B. D., Bretz, R. L., & Novak, J. D. (1994). Concept maps as a tool to assess instruction in chemistry. *Journal of Chemical Education, 71*, 91-115.

Pillay, H. (1997). Adult learning in a workplace context. In P. Sutherland (Ed.), *Adult learning: A reader*. London: Kogan Page Limited.

Popham, W. J. (1998). Farewell, curriculum: Confessions of an assessment convert. *Phi Delta Kappan, 79*, 380-384.

Redish, E. F. (1996). *Discipline-based education and education research: The case of physics*. Retrieved 18/05/2002, from http://www.physics.umd.edu/perg/papers/redish/nas/nas.htm

Reed, D. S., & McNergney, R. F. (2000). *Evaluating technology-based curriculum materials. ERIC Digest*. Retrieved 7/12/02, from http://www.ed.gov/databases/ERIC_Digests/ed449118.html

Reeves, D. (2002). *The leaders guide to standards*. San Francisco: Jossey-Bass.

Roeber, E. D. (1996). Guidelines for the development and management of performance assessments. *Practical Assessment, Research & Evaluation, 5*(7).

Rogers, G. & Sando, J. (1996). Stepping Ahead: An Assessment Plan Development Guide, Rose-Hulman Institute of Technology, Terre Haute, Indiana.

Rompelman, O. (2000). Assessment of student learning: Evolution of objectives in engineering education and the consequences for assessment. *European Journal of Engineering Education, 25*(4), 339-350.

Rust, C., Price, M., & O'Donovan, B. (2003). Improving students' learning by developing their understanding of assessment criteria and processes. *Assessment and Evaluation in Higher Education, 28*(2).

Safoutin, M. J., Atman, C. J., Adams, R., Rutar, T., Kramlich, J. C., & Fridley, J. L. (2000). A design attribute framework for course planning and learning assessment. *IEEE Transactions On Education, 43*(2), 188-199.

Saterfiel, T. H., & McLarty, J. R. (1995). *Assessing employability skills. ERIC Digest*. Retrieved 7/12/2002, from http://www.ed.gov/databases/ERIC_Digests/ed391109.html

Scott, D., & Usher, R. (1999). *Researching education: Data, methods and theory in educational enquiry*. London: Cassell.

Scottish Qualifications Authority. (2001). *Guide to assessment and quality assurance for colleges of further education*: Scottish Qualifications Authority, Glasgow.

Shaeiwitz, J. A. (1996). Outcomes assessment in engineering education. *Journal of Engineering Education, July 1996*, 239-246.

Shuman, L., Besterfield-Sacre, M. E., Wolfe, H., Atman, C. J., McGourty, J., Millar, R. L., et al. (2000). *Matching assessment methods to outcomes: Definitions and research questions.* Paper presented at the ASEE Annual Conference and Exposition, St. Louis, MO.

Siraj-Blatchford, I., & Siraj-Blatchford, J. (1997). Reflexivity, social justice and educational research. *Cambridge Journal of Education, 27*(2), 235-248.

Sissons, L. (2002). Facing up to the future. In *Voices | He Reo: New directions in workplace learning* (pp. 20-21). Wellington: Skill New Zealand.

Skill New Zealand (2001). *Moving forward: Skills for the knowledge economy*. Wellington: Skill New Zealand.

Skill New Zealand. (2002). *Voices | Te Reo: New directions in workplace learning | He huarahi Akoranga hou | Te wahi mahi*. Wellington: Skill New Zealand.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1998). Creating a learning environment by using self-, peer- and co-assessment. *Learning Environments Research, 1*(3), 293-310.

Stake, R. E. (1997). Case study methods in educational research: Seeking sweet water. In R. M. Jaeger (Ed.), *Complementary methods for research in education* (2nd ed., pp. 401-414). Washington: American Educational Research Association.

Standen, P., McKenna, R., & Williams, M. (1998, February). Using the ignorance paradigm to teach lifelong learning skills. In B. Black & N. Stanley (Eds.), *Teaching and Learning in Changing Times* (pp. 313-317). Perth: Proceedings of the 7th Annual Teaching Learning Forum, The University of Western Australia.

Stephenson, J., & Weil, S. (1992). *Quality in learning: A capability approach in higher education*.

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Newbury Park: Sage.

Suskie, L. (2000). Fair assessment practices. *AAHE Bulletin, May 2000*.

Swezey, R. W. (1981). *Individual performance assessment: An approach to criterion-referenced test development*. Reston, Virginia: Reston Publishing Company, Inc.

Taber, K. S. (2000). Case studies and generalizability: Grounded theory and research in science education. *International Journal of Science Education, 22*(5), 469 - 487.

Tan, K. H. K., & Prosser, M. (2004). Qualitatively different ways of differentiating student achievement: a phenomeno graphic study of academics' conceptions of grade descriptors. *Assessment and Evaluation in Higher Education, 29*(3), 267-282.

Taras, M. (2002). Using assessment for learning and learning from assessment. *Assessment and Evaluation in Higher Education, 27*(6), 501-510.

Tertiary Education Advisory Commission. (2000). *Shaping a shared vision: Initial report of the Tertiary Education Advisory Commission*. Wellington: Tertiary Education Advisory Commission.

The Conference Board of Canada (2000). *Employability skills 2000+*. Retrieved 17/12/2002, from http://www2.conferenceboard.ca/education/learning_tools/esp2000.pdf

Thomson, P., Mathers, R., & Quirk, R. (1996). *The grade debate: Should we grade competency-based assessment?* Adelaide: National Council for Vocational Education Research.

Tierney, R., & Marielle, S. (2004). What's still wrong with rubrics: Focusing on the consistency of performance criteria across scale levels. *Practical Assessment, Research & Evaluation, 9*(2).

Tillema, H. H., Kessels, J. W. M., & Meijers, F. (2000). Competencies as Building Blocks for Integrating Assessment with Instruction in Vocational Education: a case from The Netherlands. *Assessment & Evaluation in Higher Education, 25*(3), 265 - 278.

Toohey, S. (2002). Assessment of students' personal development as part of preparational for professional work-is it desirable and is it feasible. *Assessment and Evaluation in Higher Education, 27*(6), 529-538.

Tough, A. (1993). Self-planned learning and major personal change. In R. Edwards, S. Sieminski & D. Zeldin (Eds.), *Adult learners, education and training*. London: Routledge.

Trevisan, M. S., Davis, D. C., Calkins, D. E., & Gentili, K. L. (1999). Designing sound scoring criteria for assessing student performance. *Journal of Engineering Education, 88*(1), 79-85.

Tuckman, B. W. (1999). *Conducting educational research* (5th ed.). Orlando: Harcourt Brace College Publishers.

Tuettemann, E. (2003). Grounded theory illuminates interpersonal relationships: an educator's perspective. In T. O'Donoghue & K. Punch (Eds.), *Qualitative Educational Research in Action: Doing and Reflecting* (pp. 7-25). New York: RoutledgeFalmer.

Turns, J., Atman, C. J., Member IEEE, & Adams, R. (2000). Concept maps for engineering education: A cognitively motivated tool supporting varied assessment functions. *IEEE Transactions On Education, 43*(2), 164-173.

U.S. Congress Office of Technology Assessment. (1992). *Testing in American Schools: Asking the right questions (OTA-SET-519)*. Washington, DC: U.S. Government Printing Office.

Viskovic, A. (2006). Becoming a tertiary teacher: learning in communities of practice. *Higher Education Research & Development*, 25(4), 323–339.

Walczyk, J. J., & Ramsey, L. L. (2003). Use of learner-centered instruction in college science and mathematics classrooms. *Journal of Research in Science Teaching, 40*(6), 566-584.

Walklin, L. (1993). *The assessment of performance and competence: A handbook for teachers and trainers*. Cheltenham: Stanley Thornes (Publishers) Ltd.

Watson, M., Nicholson, L., & Sharplin, E. (2001). *Review of research: Vocational education and training literacy and numeracy*. Leabrook SA: NCVER.

Wiggins, G. (1990). The case for authentic assessment. *Practical Assessment, Research & Evaluation, 2*(2).

Wiggins, G. (1993). *Assessing student performance: Exploring the purpose and limits of testing*. San Francisco: Jossey-Bass Publishers.

Wikipedia. (n.d.). *Taxonomy of Educational Objectives*, from http://en.wikipedia.org/wiki/Taxonomy_of_Educational_Objectives

Wiliam, D. (2000a). *Integrating summative and formative functions of assessment.* Paper presented at the First annual conference of the Association for Educational Assessment-Europe, Prague, Czech Republic.

Wiliam, D. (2000b). The meanings and consequences of educational assessments. *Critical Quarterly, 42*(1), 105-127.

Williams, M., & Bateman, A. (2003). *Graded assessment in vocational education and training: An analysis of national practice, drivers and areas for policy development*. Leabrook: National Centre for Vocational Education Research.

Zessoules, R., & Gardner, H. (1991). Authentic assessment: Beyond the buzzword and into the classroom. In V. Perrone (Ed.), *Expanding student assessment* (pp. 47-71): Association For Supervision and Curriculum Development.

APPENDIX A

THEORETICAL MODEL CATEGORY OBJECTIVES

During the process of the grounded theory approach to the identification and creation of categories for the theoretical model, the data was collated into sets of objectives, statements or principles of good practice for each category. Following this compilation, the sets of statements were reformated into readable prose or discourse for the benefit of the reader as provided in chapter four. For those readers who wish to use the data in their specific statements format as a focus or check list, a number of these categories are produced below in their original format.

Assessment Principles

Assessment should:-

- Be an important part of education that is used for the enhancement of learning.
- Clearly express and communicate the goals of the curriculum.
- Be an integral component of the curriculum.
- Be a dynamic part of the teaching-learning process and motivate students to learn.
- Be inextricably linked with the learning process.
- Reflect the quality and value of the total education and subject experiences.
- Be a reflection of the richness of the learning process.
- Assist students and teachers as they accomplish their goals.
- Assist the teacher to learn from the student's experience.
- Assist teachers as they reflect upon the teaching-learning process, as well as the essence of the curriculum program at large.
- Provide students with experiences that promote the how of scientific inquiry, rather than merely exposing them to what is known about and by science.
- Engage students in the kind of intellectually stimulating and invigorating assessments that further contribute to their understandings of science.
- Encourage students to see their active engagement in the assessment process as a part of their involvement in learning.
- Provide feedback to enable students to improve their understanding.
- Diagnose misunderstandings to assist students to learn more effectively.

Assessment may be:-

- Formative assessment, which requires the student to...
  - Recognise that there is a gap between his or her current understanding or skill level and the desired understanding or skill level.
  - Take effective action to close that gap.
  - Understand both the process of formative feedback and how this process applies to his or her work.
- Summative assessment, which is an 'overview of previous learning'
  - 'Summing-up' means creating a picture of achievement based on accumulating assessments that were originally formative.
  - 'Checking-up' means using tests or tasks at the end of learning that are assigned specifically to collect information for summative judgements.

Fair Assessment

Fair assessment practices should:

- Have clearly stated learning outcomes.
- Match the assessment to what is taught (i.e. the curriculum).
- Use many different measures and many different kinds of measures.
- Help students learn how to do the assessment task by providing clear instructions and good examples.
- Engage and encourage students in their performance.
- Include appropriate interpretation of assessment results.
- Provide feedback that will improve the students' learning.

Good Practice Assessment Principles

Principles of good practice for assessing student learning:-

- The assessment of student learning begins with educational values.
- Assessment is most effective when it reflects an understanding of learning as multidimensional, integrated and revealed in performance over time.
- Assessment works best when the programs it seeks to improve have clear,

explicitly stated purposes.

- Assessment requires attention to outcomes but also and equally to the experiences that lead to those outcomes.
- Assessment works best when it is ongoing not episodic.
- Assessment makes a difference when it begins with issues of use and illuminates questions that people really do care about.
- Assessment fosters wider improvement when representatives from across the educational community are involved.
- Assessment is most likely to lead to improvement when it is part of a larger set of conditions that promote change.
- Through assessment, educators meet responsibilities to students and to the public.

Learning Goals and Outcomes

Learning goals and outcomes

- The statement of goals and accompanying learning outcomes should provide a clear focus for both instruction and assessment.
- Both goals and outcomes should reflect knowledge and information that is worthwhile for students to learn.
- The relationship between a given goal and the outcomes that describe that goal should be apparent.
- All of the important aspects of the given goal should be reflected through the outcomes.
- Outcomes should describe measurable student outcomes.

Learning outcomes

- Are also known as behavioural objectives, learning objectives, instructional objectives or performance objectives.
- Are terms that refer to descriptions of observable student behaviour or performance that are used to make judgements about learning.

Learning outcomes have three essential parts:-

- Condition - which describes the conditions (i.e. the circumstances, commands, materials, directions, etc.) under which the behaviour is to be performed.

- Behavioural verb - the action word that suggests an observable feature of the students' performance.
- Criteria - a statement that specifies how well the student must perform the task.

Learning outcomes should:-

- Serve to clarify the purposes and intent of instruction for teachers and students.
- Communicate to the students in a consistent, orderly and efficient manner what they are to learn.
- Provide the basis for lesson planning and focus the attention of the teacher on student learning.
- Focus the teacher on the design of their classroom instructional events to provide on-target instructional activities and promote students' mastery of the outcomes.
- Promote the teacher's understanding of the end point of instruction and the relevance their explanations, modelling, and practice activities.
- Empower teachers to evaluate whether their instructional efforts have been effective and that learning has taken place.
- Minimise the teaching approach of merely dishing out instruction and hoping for the best.
- Be associated with clearly defined assessment instruments to determine whether the outcomes have actually been achieved.

Authentic Assessment Principles

Authentic Assessments should…

- Allow the use of alternative assessment to accommodate varied learning styles and multiple human judgements of learning.
- Present engaging and meaningful problems or tasks that are applicable to real-life contexts and situations and to prepare students for the workforce.
- Present the curriculum to students in the form of rich situational problems that helps them learn how to apply their skills to authentic tasks and projects.
- Require students to understand the nature of high quality performance in a job related situation, conveying in their response that both development and achievement are important by placing an emphasis on the process and result.
- Provide multistaged-demonstrations of knowing, knowing why, and knowing

how.

- Require students to consider the task as a whole and not just simple elements, to reveal how they went about solving the task, not just provide the solution to the task.
- Be adaptable, flexible, ongoing, and cumulative, and allow other learning opportunities to arise during assessment.
- Include a variety of assessment items that gives students time to think, construct their own responses, demonstrate the depth of their knowledge and understanding and solve problems in different ways.
- Provide assessment that measures students' productivity, performance and thinking.
- Present rich, multidimensional, varied formats, both on-demand (in-class exercises) and cumulative (portfolios).
- Be carefully designed to have relevance to the curriculum and closely align the content and learning outcomes with the problems or tasks.
- Provide assessment that is not only derived from the curriculum but is an integral part of teaching and is part of the feedback loop linked to the students' learning.
- Present a learning environment that promotes thinking and reasoning skills, allows students to work individually or in small groups, and develop attitudes and dispositions such as persistence, reflection, participation and enthusiasm.
- Encourage learners to demonstrate a diverse understanding of what they have learnt and can do so that they can see the growth of their learning over time.
- Communicate to the students an awareness and a fairness in scoring procedures through clear, concise, and openly communicated standards of assessment processes and encourage them to take ownership of their learning.
- Provide opportunities for learner self-evaluation, feedback to themselves and to others.
- Focus on students' conceptual insights and analytical skills; their ability to integrate what they learn, creativity, ability to work collaboratively, and written and oral expression skills.
- Help students develop skills that will cope with ambiguity, to perceive patterns and to solve unconventional problems.
- Provide a range of opportunities for individual performance as well as group work.

Planning and Developing Assessment

Development of the framework for the assessment…

- Serves as the guide to the entire assessment
- Consists primarily of the course and lesson objectives set out to ensure that each is assessed.

Steps for the development of performance assessments, include...

- Identify goals and course outcomes.
- Identify specific learning objective(s) for each broad goal.
- Develop performance criterion(s) for each learning objective.

Assessment plans have three components -

- A statement of educational goals, in order to define exactly what is expected of students.
- A valid set of assessment instruments, in order to achieve multiple measures of student achievement of the goals.
- A feedback path so that the resulting performance information can be used to improve teaching and student performance.

Creation of the assessment plan…

- That is developed from the assessment framework
- It is used to provide an overview of the types of assessment to be developed and used.
- And describes the types of assessments that are to be used and how assessments will be administered, scored, and reported.

Production of the assessment design…

- This will describe the characteristics of an adequate assessment for each content area of the assessment framework
- And should guide the development of the assessment instruments for each objective that are needed in keeping with the available resources.
- Means for feedback to the student.
- Evaluation of whether the performance criteria were met and the objectives

achieved.

- Marking schedules and/or criteria to be used to assess student responses.
- Samples of how the students could respond and how such responses will be recorded and scored.

Performance-Based Instruction

Seven principles of performance-based instruction

- Establish Clear Student Outcomes, so that…
  - The curriculum is the focus in terms of desired performances of understanding.
  - The curriculum, instruction, and assessment relate together with the performance targets.
  - Performance assessments become targets for instruction and learning.
  - Students can demonstrate their understanding of their learning goals and objectives through performance assessment.

- Strive for Authentic Assessment
  - Students should be involved in authentic work related tasks.
  - Performance tasks should require students to demonstrate their knowledge and skills in a manner that reflects the real world.

- Communicate Assessment Criteria and Performance Standards
  - Because authentic performance tasks rarely have a single, correct answer, evaluation of student products and performances should be based upon judgment and guided by clear criteria.
  - The criteria are best incorporated into a clear and well-defined scoring tool (e.g., rubrics, rating scales, or performance lists).

- Provide Examples of Proficiency
  - Students should be provided with examples that illustrate excellence in performance so that they know what excellent work looks like.
  - Models of quality work can assist the instructor in performance-based instruction in the classroom.

- Teach Strategies Explicitly
  - To assist students improve their performance on academic tasks. Use techniques such as purpose of the strategy, demonstration of use, practice by students under the guidance of the instructor so that students can then independently and/or in teams, regularly reflect on the appropriate uses of the strategy and its effectiveness.

- Use On-Going Performance Assessment for Feedback and Improvement
  - On-going quality formative assessment to provide feedback for improvement is very important.
  - Practice, an adjustment based on feedback, and more practice develops deep understanding and proficiency.

- Document and Recognize Progress
  - Regular and quality feedback assists in developing students' sense of achievement.
  - Portfolios or other collections of student work are a way of documenting progress.

Creating Meaningful Performance Assessments

Performance assessment

- May be defined as a method of assessment that requires students to create an answer or perform an exercise that demonstrates their knowledge and skills such as doing mathematical calculations, conducting experiments, writing extended essays, etc.
- Is best understood as a continuous sequence of assessment formats ranging from simple student-constructed responses to comprehensive demonstrations or collections of work over a period of time.
- Uses the terms 'Performance' (the generation of a response by a student that is observed either directly or indirectly) and 'Authentic' (where the task and the context in which the assessment occurs is relevant and represents "real world" problems or issues) to measure what is taught in the curriculum.

Performance Assessments should:-

- Measure important learning outcomes and motivate high performance.
- Require the demonstration of complex understanding and thinking applicable to important problem areas.
- Reflect what is taught and how it is taught through a series of theoretically and practically coherent learning activities that mirror the learning objectives and expected student outcomes.
- Should interact with instruction that precedes and follows an assessment task.
- Promote self-assessment when the scoring criteria are well articulated.
- Provide formative feedback to the students that assists with remedial assistance.
- Provide clear indicators of student performance that can be linked to instructional actions.
- Be compatible with a variety of instructional models.
- Be easily administered, scored, and interpreted by teachers.
- Communicate the goals of learning to teachers and students.
- Generate accurate, meaningful information (i.e., be reliable and valid).
- Be associated with typical examples of current standards or quality of subject matter.
- Contain written and oral explanations of tasks should be clear and concise and presented in language that the students understand.
- Be associated with the appropriate tools that need to be available to support the completion of the assessment activity.

Assessment for Skills Development

Traditional learning and assessment methods have:-

- Emphasized training in professional skills in undergraduate education in engineering, computer science and mathematics.
- Not encouraged students to analyze, judge, communicate or discuss these skills.
- Used examinations that actually inhibit the development of the students ‘ independence and creativity.
- Used an examination that often consists of problems that the students solve individually. Therefore it is difficult to give complex and/or loosely defined problems in such an examination.
- Developed a surface approach to learning where the student sees learning as a means to achieve an end.

- Students who see learning as a means to an end are motivated by an extrinsic objective and they will commit unrelated facts to their short term memory but are unlikely to be able to establish meaning or relationships between or within given tasks.

Students' life and work skills can be developed by:-

- Increasing the students' involvement in, and responsibility for, their studies;
- Improving the students' communications skills;
- Strengthening the students' ability to think in abstract terms and to generalize;
- Encouraging the students to develop a creativity in their subjects;
- Improving the students' study habits.

Changing the learning environment and assessment method, student centred learning and authentic assessment, can:-

- Positively influence the students' attitudes towards their studies.
- Stimulate creativity and communication skills.
- Prepare students for work in a changing world and for lifelong learning.
- Promote the creation of creative, adaptable students who are receptive to new situations.
- Encourage students to:-
    - Develop a deep approach to learning
    - Be personally involved in the task
    - Seek to obtain some underlying meaning,
    - Aim to understand relationships between the immediate task and other tasks or contexts.
    - Develop a better ability to think abstractly, the ability to generalize, creativity and the ability to structure, important skills for engineering students.
    - Read extensively around a given topic, to discuss the topic and ultimately to achieve higher grades on assessment tasks than students who use a surface approach.

Competency-Based Education

Competency-based education…

- Can also be called outcome-based education, or assessment.
- Specifies the outcomes students should be able to demonstrate upon completion of their studies.
- Uses the term competency to mean the ability of a student to utilise their knowledge, skills, capabilities, attitudes and behaviours in order to perform a task according to the specified level of competency, i.e. the required standard of performance.
- Recognises that competency cannot be directly observed but rather it is a transparent concept that can be observed in a given context of validated behaviours that the student can demonstrate.
- Focuses educational practice on ensuring that students master the specified outcomes.
- Concentrates on students graduating having demonstrated mastery of the whole of a defined set of competencies rather than a graduation based on an accumulated grade, and which, quite probably, that has demonstrated knowledge that is strong in one section and weak in another.
- Has two requirements - the learning outcomes must be identified, made explicit and communicated to all concerned, (students, teachers and employers) and these outcomes should be the focus of educational decisions.
- Requires that the educational outcomes are clearly and unambiguously specified,
- Learning activities should be considered in terms of its expected outcomes.
- Provides a much wider education focus on the use of skills rather than just knowledge or skill acquisition.
- Requires a student to acquire knowledge, be able to use it efficiently and to transfer it to other situations.
- Offers a powerful tool for modifying, designing, managing and evaluating engineering curricula.
- Facilitates the learning towards active learning rather than passive learning.
- Encourages students to take more responsibility for their own learning.
- Helps to integrate technical content with foundation skills in the teaching/learning process.
- Provides realistic applications and the portability of skills across experiences, and increases relevance for learners.
- Provides tools for curriculum evaluation and improvement.

- Requires teachers have a detailed understanding of their own contribution to the curriculum as facilitators as well as teachers.

Competency-Based Assessment plans have:-

- A statement of educational goals, in order to define exactly what is expected of students.
- A valid set of assessment instruments, in order to achieve multiple measures of student achievement of the goals.
- A feedback path so that the resulting performance information can be used to improve teaching and student performance.

Designing a Competency-Based Curriculum

Design suggestions towards a clear and unambiguous framework for curriculum planning.

Competencies:–

- produce a clear statement of the competencies to be demonstrated by each student upon graduation.
- Avoid a long list of competencies because they become unmanageable and hard to apply in practice.
- Express competencies so that they are broad in their vision yet specific enough to be focused on and measured effectively.

Assessment:-

- Should be developed for each activity according to the desired level of performance.
- Must determine whether the learner has met the specified level of performance.
- Encourages the development of non-traditional assessment techniques.
- Criteria and conditions by which performance will be assessed are explicitly stated.

Curriculum Map:-

- Is used to formulate individual learning activities from learning outcomes.
- Assigns responsibility to the learning and performance tasks where the competencies will be addressed.

- Sequences competency performances based on a logical and gradual mastery of skills, up to the level of performance required by the course standard.

Learning activities:-

- Focuses on the specific design of each learning activity.
- Describes the development of supportive media related to the skills to be developed.
- Aligns activities with the learning outcomes in a structured manner.
- Each activity must describe, first the competencies it addresses.

The Implementation Of A Competency-Based Curriculum requires:-

- Simultaneous changes in program, instruction and assessments practices.
- Project and problem-based learning as instruction tools.
- Different types of learning activities, for example, class tutorials, individual practical activities, group activities.
- Supplementation of class learning by Lab work (usually teams of 2 people) working on relating theory to working circuits.
- Project-based learning, in order to provide an authentic engineering environment and promotes "real world" skills intended to simulate professional situations.
- Authentic assessment is a major component of the project as is problem-based learning.
- Development of students' content knowledge and skills acquired during the project production process.
- Staff to work together in teams as tutors, lab assistant, and resources provider to provide and assess all student-learning activities.

Adult Learning Environment

Learning environments that foster adult student constructivist learning that prepares them for the workplace, should…

- Demonstrate the correlation between learning to think and learning to work.
- Help students develop connections between subject content and the context of application
- Develop each student's understanding of their thought processes and self-

evaluative skills so they can assess what they need to learn in order to solve a problem or complete a project.

- Help students expand the ability of the thinking brain to solve problems.
- Require students assimilate and demonstrate knowledge in a way that can be useful in new situations.
- Provide students with a learning environment where they search for meaning, appreciate uncertainty, and inquire responsibly.
- Should provide opportunities for students to make connections with their own life experiences.
- Avoid situations where students only develop an ability to memorize facts in a textbook.
- Help students develop the capabilities of their brain to make the connections between knowledge and the application of knowledge.
- Implement practices that encourage students to think and rethink, demonstrate, and exhibit.
- Encourage student-to-student interaction, initiate lessons that foster cooperative learning, and provide opportunities for students to be exposed to interdisciplinary curriculum.
- Lead students to engage in higher-order thinking and provide opportunities for students to process information through various avenues of expression--written, oral, building, drawing, etc.
- Supplement programs with transitional components such as academic skills, productive work habits, work values, and career decision-making skills.
- Encourage students to direct their own learning, to recognize what skills they need, to learn their skills on their own and involve themselves in lifelong learning that continually prepares them for new employment and career opportunities.
- Offer students an expanded focus for vocational education, one that extends beyond the limits of job training.
- Should initiate connected and constructivist ways for students to think and learn as important aspects of career development and appreciate the contribution they make to students' development of career interests, choice, planning, and performance.
- Invite students to search for understanding, appreciate uncertainty, and inquire responsibly, while accepting the uncertainty that is accompanies them as they

pursue areas that are new to them.

- Require educators who are willing to take risks, to forego the need for 'control' and to allow students to pursue their own learning, to ask their own questions and seek their own answers.

Good Practice in Undergraduate Education

Good practice in undergraduate education should…

- Encourage student-faculty contact.
- Encourage cooperation among students.
- Encourage active learning.
- Give prompt feedback.
- Emphasize time on task.
- Communicate high expectations.
- Respect diverse talents and ways of learning.

Twelve attributes of quality in undergraduate education:

- The organizational culture must have
  (1) high expectations,
  (2) respect for diverse talents and learning styles, and
  (3) an emphasis on the early years of study.
- A quality curriculum requires
  (4) coherence in learning,
  (5) synthesis of experiences,
  (6) ongoing practice of learned skills, and
  (7) integration of education and experience.
- Quality instruction incorporates
  (8) active learning,
  (9) assessment and prompt feedback,
  (10) collaboration,
  (11) adequate time on task, and
  (12) out-of-class contact with faculty.

Collaborative Learning

Collaborative learning, cooperative learning, peer learning and group learning are interchangeably used to define an instruction method that…

- Encourages students to work together in small groups toward a common goal such as the accomplishment of an educational task.
- Provides a more comfortable atmosphere for minority groups such as overseas, female and mature students.
- Promotes the improvement in communication skills as students are given an opportunity to express their thoughts openly.
- Uses study groups that provide the students with real life experiences, which could be utilized in their upcoming career.
- Allows for critical-thinking items that involve analysis, synthesis, and evaluation of the concepts.

Working in collaborative learning groups:-

- Requires the teacher to act as a facilitator of learning, not a giver of information.
- Improves students' critical thinking.
- Improves problem-solving strategies.
- Contributes positively to the learning process especially when there is diversity in the group.
- Elicits reasons from students for their judgements and decisions.
- Helps in the understanding process.
- Pools knowledge and experience.
- Encourages helpful feedback.
- Stimulates thinking.
- Provides new perspectives.
- Requires greater responsibility for self and the group.

Student-Centred Learning

Student-centred learning requires:-

- That students must take an active role so that their learning will occur deeply, endure, be enjoyable, and transfer to contexts beyond the classroom.
- Instruction from a learner-centred perspective to facilitate student construction

of knowledge.

- That students construct their own learning, building on the beliefs, knowledge and understanding they bring with them.
- Promotes successful learner-centred learning that can achieve many positive advantages for teaching staff and students.

Learner-centred instruction embedded in constructivism principles, requires:-

- Tutors who respect diverse talents and ways of learning among their students.
- Tutors who provide prompt, constructive feedback on student performance.
- Frequent student-faculty interaction
- Tutors who keep students focused on their learning, not on other distractions.
- Cooperative learning activities that are interspersed among other engaging instructional formats.
- Authentic assessment tasks as well as traditional assessment tasks.
- Learning activities that attract students' interest.
- Students that are actively involved in their learning.
- Students who become autonomous learners as they become aware of the process of learning itself.
- Communication of clear learning objectives to students.
- The use of graphical learning aids to help students understand relationships between concepts.
- Students who recognise that the material to be learned is important.
- Students who relate new material to information they already know.
- Students who act on the information at a deep level.
- Students who continually check and update their understandings based on new experiences.
- Students who transfer new learning automatically to new contexts to which it is relevant.

Assessment Towards In-Depth and Student-Centred Learning

To promote in-depth and student-centred learning, assessment should:-

- Be designed to match the learning goals.
- Identify if the chosen learning goal is being reached or satisfied.

- Associated with clearly promoted and established sets of criteria or rubrics to assess student work.
- Include formative assessment to determine the learner's level of success in reaching the desired goal and provide feedback.
- Include self-assessment, which requires students to evaluate their own participation, process and products.
- Include summative assessment or achievement tests to help the instructor determine the level of achievement of an ability to carry out a given task and to determine the learner's level of proficiency.
- Consider grading if it is necessary to indicate the degree of success of the student in the assigned task.
- Include a process whereby the criteria of assessment and the final summative assessment in terms of marks are made very clear to both the students and the instructors.

Assessment for in-depth and student-centred learning can include…

- Short investigations to assess how well students have mastered basic concepts and skills using words such as interpret, describe, calculate, explain, or predict.
- Open-response questions present students with a stimulus and ask them to respond with a response such as a brief written or oral answer, a mathematical solution, a drawing, diagram, chart or graph.
- Portfolios that document learning over time, promotes student improvement and teaches students the value of self-assessment, editing and revision.

Scoring Rubrics

Performance rubrics:-

- Provide a means to assess postsecondary academic skills on the basis of such a scale that presents a continuum of performance levels, defined in terms of selected criteria, towards to full attainment or development of the targeted skills.
- Have two common features, a list of criteria and graduations of quality.
- Provide a framework that helps assessors to be consistent, focuses the attention of assessor and assessed on important outcomes, and establish benchmarks for documenting progress.

- Feature a rating scale based on a stated standard, objective, behaviour, or quality;
- Assist teachers to evaluate papers or projects because they know what makes a good final product and why.
- Are teaching tools that support student learning and the development of thinking skills.
- Make the assessment of student work quick and efficient.
- Help students to understand how they will be evaluated and they can prepare accordingly.
- Provide a grid of criteria necessary to improve students' work and increase their knowledge.
- Guide students to build on existing knowledge.
- Reflect on and reveal problems will be more informative to students than vague levels of quality or a simple numeric mark.
- Can help improve students' end products and therefore increase learning.
- Are more likely to provide qualitative, meaningful, and stable appraisals than traditional scoring methods.
- Are easy to use and explain, they are concise and digestible.
- Are transparent to students and make teacher's expectations very clear.
- Provide students with more informative feedback about their strengths and areas in need of improvement than traditional forms of assessment.
- Help students learn in a way that they cannot learn from a mark.
- Support the development of good thinking, skills and understanding.

Computer Simulated Laboratory Learning

An appraisal of the literature relating to computer-simulated laboratory learning revealed that the computer simulation of laboratory tasks could…

- Be used to replace a traditional laboratory in an electrical engineering course.
- Provide lower cost and easy-to-schedule lab time critical to enable learners to develop knowledge and skill.
- Provide simulated labs with equivalent learning performance as alternatives to physical labs for those courses that require application of theory.
- Be used at any time and any place to facilitate life-long learning.
- Provide students in technical professions with a flexible schedule with highly

productive learning time.

- Be integrated with curriculum and instruction to become a powerful learning tool.
- Support collaborative learning.
- Facilities learning and the learning strategies that it enables.
- Bring real-world examples into the classroom and provide opportunities for authentic assessment.
- Provide learning simulations that typically require job-like performance, thus active learning is inherent in the methodology.
- Reveal the concepts being examined more clearly and can result in improved student understanding for the type of experiment where the traditional laboratory does not make concepts physically available to our senses.
- Stimulate the development of higher order thinking and problem-solving skills.
- Enhance the conceptual understanding of complex, naturally occurring situations and events by integrating technology and subject matter
- Provide challenging evaluative simulations that integrate assessment, learning and performance support.
- Provide opportunities for exploration and learning beyond the minimum level of learning.

APPENDIX B

COPYRIGHT APPROVAL FORM FOR EMPLOYER SKILLS SURVEY

Department of
Communications
Information Technology
and the Arts

Contact: Roger Edwards
Telephone: 02 6271 1351
Fax: 02 6271 1633
email: Commonwealth.copyright@dcita.gov.au
ABN: 51 491 646 726

Mr Don Hewison

Address blanked to promote non-disclosure of teaching institution

Copyright Request - Reference Number 6206

Dear Mr Hewison

I refer to your letter of 17 January 2003 in which you seek permission to reproduce and adapt from the following Commonwealth of Australia copyright material:

- Employer Satisfaction with Graduate Skills

for inclusion in a your own questionnaire and thesis.

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Yours sincerely

Roger Edwards
Commonwealth Copyright Administration
Intellectual Property Branch

24 February 2003

APPENDIX C

FORMS AND QUESTIONNAIRE USED FOR EMPLOYER SURVEY

Skills Profile for a Graduate of a Diploma in Technology

Initial Phone Questionnaire

<Company name> ID: <number>

<Company address1, address2, City> Ph: <phone number>

<Company service>

INTRODUCTION

Good morning/afternoon. My name is …………… calling on behalf of the <<MYTEC>> Department at the <<MYTEC institution>>. I would like to speak to the person at your workplace responsible for staff recruitment, particularly for technician staff.

If speaking to the staff recruiter as the initial contact, go to a)

(If initial person is unsure who to direct call to) Do you have a human resources or personnel section?
(If staff is recruited at another location, e.g. a head office or engineering division, obtain the name and phone number of a contact there)

When speaking to the staff recruiter if different from initial contact …
Reintroduce yourself … ***(Continue at a)***

a) Reason for phone call…
We are conducting a research study to establish what skills industry requires of students graduating with a Diploma in Technology or Engineering (the new technician qualification that is replacing the New Zealand Certificate in Engineering).

Q1 Has your business recently recruited a new graduate technician or are you likely to recruit a new graduate technician in the future?

NO, (thank and end phone call)
YES, continue

Q2 Could you please describe the activity from which your business derives its main income?

....

Q3 We would like to send you a short questionnaire about your organisation's expectations of the skills of a new technician graduate. Are you the most appropriate person to send this questionnaire to? *(If not, then obtain the name of the most appropriate person)*

Obtain correct name and title of contact person… Check spelling with respondent…

Name ....

Title ....

Q5 What is the best address for me to send the questionnaire to?
Obtain correct business name and postal address…

<Company Name>	....
<Company address1> <Company address2> <City>	....

Thank you, we will send the questionnaire with a covering letter and a reply paid envelope. It should only take five to ten minutes to complete ***Close Suitably***

Contacted ☐ Survey Sent ☐ Survey Received ☐

Date .... Date .... Date ....

MYTEC Logo

<MYTEC>
<address>

<date>

[Click here and type recipient's title]
[Click here and type company name]
[Click here and type company address]
Att: [Click here and type recipient's full name]

Dear [Click here and type recipient's given name]

Thank you for agreeing to complete this questionnaire about the skills you require of a new graduate technician.

The objective of the survey is to determine a prioritised list of skills as desired by employers of graduate technicians to either confirm or re-establish a benchmark for students' skill based learning outcomes. This list can also serve to establish a set of goals for a programme against which programme assessment can be measured.

The questionnaire I am asking you to complete was designed and used by the Australian Commonwealth Department of Education, Employment, Training and Youth Affairs as part of a more extensive survey conducted in 2000, and is used with permission.

A reply paid envelope has been included for you to return this questionnaire. We do ask that you complete and return the questionnaire within two weeks of the date of this letter.

Be assured that your responses will be treated in complete confidence. No details regarding your identity or the identity of your organisation as being associated with any specific data will be available to any party other than my research assistant or myself.

If you have any questions please contact me on <MYTEC phone number>.

Yours sincerely,

Don Hewison
Academic Staff Member
<MYTEC> Department

MYTEC Logo *Questionnaire Reference Number* ....

Diploma in Technology Graduate Skills Survey

EMPLOYER QUESTIONNAIRE

When your organisation is recruiting a new graduate for a technician position requiring a diploma (previously NZCE) qualification, how important is it that the graduate has each of the following skills?

Please circle the appropriate number, where 1 is 'Not at all important' and 5 is 'Extremely important' If you don't know, circle DK.

	Not at all important				Extremely important	Don't know
Basic Competencies						
Literacy	1	2	3	4	5	DK
Numeracy	1	2	3	4	5	DK
Time management skills	1	2	3	4	5	DK
Basic computer skills	1	2	3	4	5	DK
Basic Skills						
Inter-personal skills with other staff	1	2	3	4	5	DK
Leadership qualities	1	2	3	4	5	DK
Oral business communication skills	1	2	3	4	5	DK
Comprehension of business practice	1	2	3	4	5	DK
Team work	1	2	3	4	5	DK
Academic Skills						
Academic learning	1	2	3	4	5	DK
Written business communication skills	1	2	3	4	5	DK
Problem solving skills	1	2	3	4	5	DK
Project management skills	1	2	3	4	5	DK
Logical and orderly thinking	1	2	3	4	5	DK
Creativity and flair	1	2	3	4	5	DK
Capacity for independent and critical thinking	1	2	3	4	5	DK
Other Attributes						
Enthusiasm	1	2	3	4	5	DK
Motivation	1	2	3	4	5	DK
Initiative	1	2	3	4	5	DK
Maturity	1	2	3	4	5	DK
Personal presentation and grooming	1	2	3	4	5	DK
Capacity to handle pressure	1	2	3	4	5	DK
Flexibility and adaptability	1	2	3	4	5	DK
Customer/client/patient focus and orientation	1	2	3	4	5	DK
Ability to benefit from on-the-job training	1	2	3	4	5	DK

Questionnaire source…
Employer Satisfaction with Graduate Skills, Research Report; Commonwealth of Australia Department of Education, Training and Youth Affairs; February 2000

APPENDIX D

STUDENT RESEARCH INFORMATION AND CONSENT FORM

STUDENTS ENROLLED IN –

• **DIRECT CURRENT CIRCUITS (ECTE401)** • **DIGITAL ELECTRONICS (ECTE403)**	**1st Semester**
• **ALTERNATING CURRENT CIRCUITS (ECTE402)** • **ANALOGUE ELECTRONICS (ECTE501)**	**2nd Semester**

Dear student

This letter to you is to outline a research project I am undertaking as part of my professional development studies. I am now into the second part of my studies towards a Doctor of Science Education degree from Curtin University in Perth, Western Australia. This part of my studies involves a research project and the writing of a thesis. I have been working through various research topics in order to focus on a topic that I believe would be of importance to me as a teacher.

The title of the research I have chosen is "Student Outcomes and Learning Environments at the Tertiary Level in New Zealand."

The focus of the research is the four, year one electrical/electronic courses you are studying and the objectives are:

> The general research question will enquire into the learning and assessment environment for the first year of a two-year electrical/electronics Diploma in Technology programme.
>
> Specifically the study will:
>
> a) Investigate the development of a suitable assessment framework to meet the requirements of the local Diploma of Technology's achievement-based assessment while at the same time meeting the requirements of the National Diploma of Technology unit standard competency-based assessment.
>
> b) Review the current practice in laboratory periods to promote an improvement of the learning environment and to investigate alternative strategies for the assessment of laboratory skills and processes to meet the assessment requirements.
>
> c) Determine a prioritised list of skills desired by industrial employers of graduate technicians to either confirm or re-establish a benchmark for students' skill based learning outcomes and to consider this list of skills in the development of the assessment instruments within the assessment framework.
>
> d) Investigate any significant differences between a school leaver's previous secondary school learning/assessment environment and the initial Diploma of Technology learning/assessment environment and whether these differences can be minimised in the development of the new assessment framework.
>
> Candidacy Proposal, Don Hewison (2002)

The *MYTEC* Diploma in Technology (Dip Tech) courses in the electrical / electronics disciplines have been designed to give students the opportunity to study for and be accredited with Unit Standards for the National Diploma in Engineering (NDE) while studying for the Diploma in Technology. This opportunity requires the assessment throughout the course be both achievement based for the Dip Tech (i.e. giving the framework and the assessment instruments while keeping in mind the objectives of the programme; i.e. to give you the opportunity to meet the assessment requirements for the diplomas and to prepare you for future employment.

The design of the research project is primarily an action research project, which in simple terms means a continual cyclic or spiral action of planning, acting, observing, reflecting then a repeat of the cycle with revised planning, acting, etc. The observation stage involves collecting data using methods such as questionnaires, interviews, personal notes, etc. Interviews and questionnaires involve me obtaining data from students while personal notes are notes I write into a diary or logbook. Any changes to the structure as they become apparent through the use of questionnaires, etc. will be investigated and put into action.

I am seeking your approval and co-operation to undertake this project. You will be asked to answer some questionnaires during the course of the project, however most of these questionnaires will be those that would be used in normal classroom practice. I would also like to arrange an interview with many of you throughout the year, outside of class time. I also need to compare individual questionnaire and interview data with individual course results.

At the end of the research phase the project will be written up into a substantial document and submitted for "marking". It will contain results of compiled data, comments from interviews, comparison with course marks, etc. My undertaking is that no individual student will be identified in that document.

I am asking you to carefully read this letter and the enclosed code of ethics under which I will conduct the research. Then could you please action…

Option A

- If you agree to be part of this research, then please write your name on the form, tick the "I **DO** consent to being part of this research project**"** box, sign and date the form and return the consent form in the attached envelope. Details from questionnaires and your assessment results will be used in the project **AND** used in the production of the report. You may be asked to agree to an interview and if so, the transcript of the interview will be offered to you to read and correct, then details from this interview will also be used to produce the report.

OR

Option B

- If you do **NOT** agree to be part of the research, then please write your name on the form, tick the "I **DO NOT** consent to being part of this research project**"** box, sign and date the form and return the consent form in the attached envelope. You will still be asked to participate in questionnaires but neither your questionnaire data nor assessment results will be used in the production of the report.

Thanks for your cooperation

Don Hewison ....

CODE OF PRACTICE AND ETHICS

As a researcher, I undertake to…

- Carry out the research in a scientifically responsible manner at all times.
- Accept responsibility for the design, methodology and execution of the research.
- Acknowledge the right of any fellow researchers to select alternative paradigms, methods and techniques.
- Recognise and honour the authority of the professional codes of specific disciplines.
- Not misuse my position as a researcher for personal gain, other than in the pursuit of further education studies.
- Summarise the proposed research in such a manner that participants understand their involvement.
- Acknowledge that participants do not abdicate their rights by consenting to participate in a research project.
- Inform the participants of the aims of the research and any implications that might reasonably affect their willingness to participate.
- Respect the right of any individual to refuse to participate in the research.
- Acknowledge that participants may withdraw their consent at any time without prejudice.
- Secure the rights of any participant and to ensure their privacy and confidentiality in the use of information about them.
- Pursue the rights of a participant to be free from undue embarrassment, discomfort, and harassment.
- Acknowledge that the interests of the participants will take precedent should any conflict between the researcher and a participant occur.
- Seek to assure participants that participation will not detrimentally affect any personal outcomes.
- Communicate the findings while subscribing to the principles of honesty and comprehensiveness.
- Accept the ethical and scientific responsibility for the research I conduct.

Don Hewison ....

ALTERNATING CURRENT CIRCUITS (ECTE402)
ANALOGUE ELECTRONICS (ECTE501)

Research project

For Don Hewison

I have read the enclosed letter outlining the purpose and requirements of this research project.

Option A

I give my consent to Don to use assessment marks from my courses, responses to any interview questions and responses from questionnaires, to use in his research and thesis report on the understanding that this information will be used in such a professional manner so as to keep my identity anonymous. I have read and accept the code of ethics under which Don will conduct the research. I also understand that at any time I can ask Don to withdraw me from this project.

I **DO** consent to being part of this research project ✓

OR

Option B

I understand the purpose of this research but I do not wish to participate in the research project.

I **DO NOT** consent to being part of this research project ✓

Please tick **ONE** of these boxes

Name ....

Signature ....

Date ....

AND

Write your name, sign the form and enter the date.

Please return this form to me in the enclosed envelope - place in the post, hand in at the Department office, or hand to me personally.

Don Hewison

APPENDIX E

FORMS AND QUESTIONNAIRE USED FOR STUDENT SURVEY

Diploma in Technology Graduate Skills Survey

STUDENT QUESTIONNAIRE - A

Dear Student

This survey questionnaire contains a list of skills or attributes that might be considered by a prospective employer when you initially seek a job position after graduating with a Diploma in Technology.

The objective in asking you to complete this questionnaire is to formulate a profile of skills as considered necessary by students when first commencing their studies. This profile will then be compared with the skills profile obtained by surveying prospective employers to provide an understanding of the developmental process through which students must pass during their studies.

It is important that you focus on what you considered important when you started the course/programme.

Please print your name below so these results can be compared with future questionnaire results.

Student Name ....

Thank you

Don Hewison

Diploma in Technology Graduate Skills Survey
STUDENT QUESTIONNAIRE - A

(Please read the other side of this survey form first)

When you first started this course/programme, how important did you consider it necessary that a graduate of a Diploma in Technology has each of the following skills?

Please circle the appropriate number, where 1 is 'Not at all important' and 5 is 'Extremely important'.

	Not at all important				Extremely important
Basic Competencies					
Literacy	1	2	3	4	5
Numeracy	1	2	3	4	5
Time management skills	1	2	3	4	5
Basic computer skills	1	2	3	4	5
Basic Skills					
Inter-personal skills with other staff	1	2	3	4	5
Leadership qualities	1	2	3	4	5
Oral business communication skills	1	2	3	4	5
Comprehension of business practice	1	2	3	4	5
Team work	1	2	3	4	5
Academic Skills					
Academic learning	1	2	3	4	5
Written business communication skills	1	2	3	4	5
Problem solving skills	1	2	3	4	5
Project management skills	1	2	3	4	5
Logical and orderly thinking	1	2	3	4	5
Creativity and flair	1	2	3	4	5
Capacity for independent and critical thinking	1	2	3	4	5
Other Attributes					
Enthusiasm	1	2	3	4	5
Motivation	1	2	3	4	5
Initiative	1	2	3	4	5
Maturity	1	2	3	4	5
Personal presentation and grooming	1	2	3	4	5
Capacity to handle pressure	1	2	3	4	5
Flexibility and adaptability	1	2	3	4	5
Customer/client/patient focus and orientation	1	2	3	4	5
Ability to benefit from on-the-job training	1	2	3	4	5

Questionnaire source…
Employer Satisfaction with Graduate Skills, Research Report; Commonwealth of Australia Department of Education, Training and Youth Affairs; February 2000

APPENDIX F

INDIVIDUAL STUDENT PROFILE QUESTIONNAIRE FORM

Individual Student Profile

Please print your name here ....

Please make your choice by drawing a circle around the corresponding number.

1. Are you studying full-time or part-time?

Full-Time	1
Part-time	2

2. Have you commenced the first year of study in the Dip Tech programme this year?

Yes	1
No	2

3. Circle the number next to the statement that best describes your background before commencing the Dip Tech programme this year.

I was attending secondary school last year.	1
I was studying at MYTEC or another tertiary education institution last year.	2
I was working/unemployed last year and have commenced study full-time this year.	3
I am employed and am studying part-time.	4
Other background.	5

4. How would you rate the transition from your previous experience (last year) to the teaching/learning environment of this year?

It has been and still is extremely difficult.	1
It has been difficult.	2
It was difficult but I am coping.	3
It has been reasonably easy.	4
Easy, straightforward, no problems.	5

5. If you are studying **Digital Electronics**…
   i. How would you rate your ability to do the mathematical 'calculations'

Extremely difficult	1
Very difficult	2
Difficult	3
Reasonably easy	4
Easy, straightforward, no problems.	5

   ii. How would you rate your ability to understand the theory?

Extremely difficult	1
Very difficult	2
Difficult	3
Reasonably easy	4
Easy, straightforward, no problems.	5

6. If you are studying **Direct Current** Circuits …
   i. How would you rate your ability to do the mathematical 'calculations'

Extremely difficult	1
Very difficult	2
Difficult	3
Reasonably easy	4
Easy, straightforward, no problems.	5

   ii. How would you rate your ability to understand the theory?

Extremely difficult	1
Very difficult	2
Difficult	3
Reasonably easy	4
Easy, straightforward, no problems.	5

7. How well do you understand the coursework assessment framework, i.e. what tests there are and the topics to be tested, the need to research and produce assignments, and the need for laboratory assessment?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

8. How well do you understand the use of the marking/scoring rubric in making a valid judgement about the 'quality' of a piece of assessment?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

9. Your peers are marking laboratory exercises. How do you rate the validity of this method of assessment?

The method of assessment is not at all valid and my grade is not acceptable.	1
I find it difficult to understand	2
The method is valid but my grades could be better	3
It seems to be valid and my grades are OK.	4
It is a valid method, my grades are OK and I am learning from doing it.	5

10. You are required to mark other student's laboratory exercises. How well do you understand what is required from you in this marking process?

I do not understand it at all.	1
I find it difficult to understand	2
It still is confusing	3
It is reasonably easy to understand	4
Easy, straightforward, no problems.	5

11. These courses require you as a student to become responsible for your own learning. Part of this responsibility is the discipline required to attend classes and make time outside of class to do revision, research for assignments and laboratory exercises. How well do you rate yourself in terms of being organised with time so you are regularly attending lectures and laboratory periods?

I am extremely disorganised	1
I am very disorganised	2
I am still disorganised	3
I am reasonably organised	4
I am very organised.	5

i. How well do you rate yourself in organising sufficient time outside of class to 'stay on top' of required work?

I am extremely disorganised	1
I am very disorganised	2
I am still disorganised	3
I am reasonably organised	4
I am very organised.	5

ii. How difficult has this process of 'getting organised' been?

Extremely difficult	1
Very difficult	2
Difficult	3
Reasonably easy	4
Easy, straightforward, no problems.	5

iii. How different is this learning environment from your previous learning experience or background before commencing the Dip Tech programme?

Extremely different	1
Very different	2
Different	3
Reasonably similar	4
Much the same, no significant difference.	5

APPENDIX G

LEARNING OUTCOMES TO BE EXTRACTED FROM CIRCUIT ANALYSIS COURSE (US16968)

Content of Unit Standard 16968 - Circuit Analysis

element 1

Describe circuit analysis concepts.

Range: concepts

electrical engineering fundamentals - Thevenin's and Norton's theorems; voltage, current and power in networks;

electronic components - operating and performance characteristics of signal amplifiers, operational amplifiers, active and passive filters, power and power switching regulators, digital to analogue and analogue to digital convertors.

performance criteria

1.1 The description provides the characteristics of the concepts.

Range: characteristics include - purpose, scope, use of concepts.

1.2 The description identifies the content and functions of associated rules, logic, and formulae.

1.3 Supporting examples provide valid illustrations of the concepts.

Range: illustrations include theoretical or practical types.

element 2

Apply circuit analysis to electrotechnology applications.

Range: applications

electrotechnology - network analysis of voltage, current and power in direct current (d.c.) and alternating current (a.c.) signal circuits; amplifier gain and feedback; single order filter analysis;

electronic circuits - analysis of common analogue and digital components including amplifiers, operational amplifiers, power regulators, digital to analogue and analogue to digital convertors.

performance criteria

2.1 The selected information sources are relevant to the given application.

Range: sources include any of - scientific texts, manufacturers data, test or experimental measurements.

2.2 The selected principles, rules, formulae, and data are relevant to the application requirement.

Range: requirements include any of - analyses, tests, experiments, theoretical or practical problems.

2.3 The application process demonstrates valid and logical use of the technology concepts, rules, formulae and data.

Range: processes include any of - mathematical or logical interpretation, manipulation, computation, presentation.

Unit Standard elements disassembled into specific learning outcomes

element 1

Describe circuit analysis concepts.

a. Describe the fundamentals of Thevenin's and Norton's theorems.

b. Describe the fundamentals of voltage, current and power in networks.

c. Describe the operating and performance characteristics of signal amplifiers.

d. Describe the operating and performance characteristics of operational amplifiers.

e. Describe the operating and performance characteristics of active filters.

f. Describe the operating and performance characteristics of passive filters.

g. Describe the operating and performance characteristics of power regulators.

h. Describe the operating and performance characteristics of power switching regulators.

i. Describe the operating and performance characteristics of digital to analogue and analogue to digital convertors.

The description should…

performance criteria

1.1 Provide a coherent statement of purpose, scope and use of concepts.

1.2 Identify content and functions.

1.3 Be supported by a valid illustration

element 2

Apply circuit analysis to electrotechnology applications.

a. Apply circuit analysis to network analysis of voltage, current and power in direct current (d.c.) signal circuits.

b. Apply circuit analysis to network analysis of voltage, current and power in alternating current (a.c.) signal circuits.

c. Apply circuit analysis to amplifier gain and feedback.

d. Apply circuit analysis to single order filter analysis.

e. Apply circuit analysis to amplifiers.

f. Apply circuit analysis to operational amplifiers.

g. Apply circuit analysis to power regulators.

h. Apply circuit analysis to digital to analogue and analogue to digital convertors.

The application should demonstrate…

performance criteria

2.1 Relevance of sources.

2.2 Relevance of principles, rules, formulae and data.

2.3 Valid and logical use of technology concepts.

Final List of Outcomes for Applied Applications (Unit Standard 16968)

US	Competency Assessment Outcome
16968.1.a	Describe the fundamentals of Thevenin's and Norton's theorems.
16968.1.b	Describe the fundamentals of voltage, current and power in networks.
16968.1.c	Describe the operating and performance characteristics of signal amplifiers.
16968.1.d	Describe the operating and performance characteristics of operational amplifiers.
16968.1.e	Describe the operating and performance characteristics of active filters.
16968.1.f	Describe the operating and performance characteristics of passive filters.
16968.1.g	Describe the operating and performance characteristics of power regulators.
16968.1.h	Describe the operating and performance characteristics of power switching regulators.
16968.1.i	Describe the operating and performance characteristics of digital to analogue and analogue to digital convertors.
16968.2.a	Apply circuit analysis to network analysis of voltage, current and power in direct current (d.c.) signal circuits.
16968.2.b	Apply circuit analysis to network analysis of voltage, current and power in alternating current (a.c.) signal circuits.
16968.2.c	Apply circuit analysis to amplifier gain and feedback.
16968.2.d	Apply circuit analysis to single order filter analysis.
16968.2.e	Apply circuit analysis to amplifiers.
16968.2.f	Apply circuit analysis to operational amplifiers.
16968.2.g	Apply circuit analysis to power regulators.
16968.2.h	Apply circuit analysis to digital to analogue and analogue to digital convertors.

The above list of outcomes is divided and added to the four other Dip Tech courses.

16968.1.a, 16968.1.b & 16968.2	DC Circuits
16968.1.f & 16968.2.b	AC Circuits
16968.1.h, 16968.1.i & 16968.2.h	Digital Electronics
16968.1.c, 16968.1.d, 16968.1.e, 16968.1.g, 16968.2.c, 16968.2.d, 16968.2.e, 16968.2.f, & 16968.2.g	Analogue Electronics

APPENDIX H

DETERMINATION OF LEARNING OUTCOMES FOR ALTERNATING CURRENT COURSE

Content of Unit Standard 16965 - Alternating Current Concepts

element 1

Describe alternating current concepts in electrical engineering.

Range: concepts

alternating current fundamentals - frequency, phase, peak and root mean square (RMS) values; properties of resistance, capacitance and inductance in alternating current (ac) circuits; characteristics of single and three phase alternating supplies; non sinusoidal waveforms and their characteristics.

electrical components - properties and performance characteristics of an electric motor, generator and single phase transformer.

performance criteria

1.1 The description provides a coherent statement of the concepts.

Range: description includes - main features, purpose, use of concepts.

1.2 The description identifies the characteristics of associated scientific rules, logic, and formulae.

1.3 Supporting practical examples provide valid illustrations of the concepts.

element 2

Apply alternating current concepts in given applications of electrical engineering.

Range: applications

electrical engineering applications - network analysis of voltage, current and power in single and three phase a.c. circuits;

electrical systems, machines and components - analysis and simple configurations of motors, generators and transformers; power factor correction.

performance criteria

2.1 The selected principles, rules, formulae, and data are appropriate for the application requirement.

Range: requirements include any of - tests, experiments, problems.

2.2 The application process demonstrates valid and logical use of the technology concepts, rules, formulae, and data.

Range: processes include any of - mathematical or logical manipulation, computation, presentation.

2.3 The application results reflect valid use, or interpretation, or adaption of the technology concepts and formulae.

Range: results include any of - the behaviour, properties of systems, equipment, components, materials.

Unit Standard elements disassembled into specific learning outcomes

element 1

Describe alternating current concepts in electrical engineering.

a. Describe frequency, phase, peak and root mean square (RMS) values.
b. Describe the concept of properties of resistance, capacitance and inductance in alternating current (ac) circuits.
c. Describe the concepts of characteristics of single phase alternating supplies.
d. Describe the concepts of characteristics of three phase alternating supplies.
e. Describe the concepts of non sinusoidal waveforms and their characteristics.
f. Describe the concepts of properties and performance characteristics of an electric motor, generator and single phase transformer.

The description should…

performance criteria

1.1 Provide a coherent statement
1.2 Identify characteristics
1.3 Be supported by a valid illustration

element 2

Apply alternating current concepts in given applications of electrical engineering.

a. Apply the network analysis of voltage, current and power in single phase a.c. circuits.
b. Apply the network analysis of voltage, current and power in three phase a.c. circuits.
c. Apply the analysis and simple configurations of motors and generators.
d. Apply the analysis and simple configurations of transformers.
e. Apply the applications of power factor correction.

The application should demonstrate…

performance criteria

2.1 Appropriateness of principles/rules/formulae/data through tests, experiments or problems
2.2 Valid and logical use of concepts/rules/formulae/data through manipulation, computation or presentation
2.3 Valid use or interpretation or adaptation of concepts and formulae through behaviour, properties, components or materials.

Final List of Unit Standard Outcomes for AC Concepts

	US	Assessment Criteria
	16965.1.a	Describe frequency, phase, peak and root mean square (RMS) values.
	16965.1.b	Describe the concept of properties of resistance, capacitance and inductance in alternating current (ac) circuits.
	16965.1.c	Describe the concepts of characteristics of single phase alternating supplies.
	16965.1.d	Describe the concepts of characteristics of three phase alternating supplies.
	16965.1.e	Describe the concepts of non sinusoidal waveforms and their characteristics.
	16965.1.f	Describe the concepts of properties and performance characteristics of an electric motor, generator and single phase transformer.
	16965.2.a	Apply the network analysis of voltage, current and power in single phase a.c. circuits.
	16965.2.b	Apply the network analysis of voltage, current and power in three phase a.c. circuits.
	16965.2.c	Apply the analysis and simple configurations of motors and generators.
	16965.2.d	Apply the analysis and simple configurations of transformers.
	16965.2.e	Apply the applications of power factor correction.
Plus		*Content of Unit Standard 16968 - Circuit Analysis*
	16968.1.f	Describe the operating and performance characteristics of passive filters.
	16968.2.b	Apply circuit analysis to network analysis of voltage, current and power in alternating current (a.c.) signal circuits.

Outcomes for Alternating Current Circuits (ECTE402) combined with Unit Standard 16965 / part 16968

Topic	Unit Standard 16965 Outcomes		Dip Tech ECTE402 Outcomes	
A	16965.1.a	Describe frequency, phase, peak and root mean square (RMS) values.	3	Demonstrate an understanding of the nature of sinusoidal alternating voltages and currents.
	16965.1.c	Describe the concepts of characteristics of single phase alternating supplies.		
B	16965.1.b	Describe the concept of properties of resistance, capacitance and inductance in alternating current (ac) circuits.	4	Describe the behaviour of reactive components in an ac circuit.
	16965.2.a	Apply the network analysis of voltage, current and power in single phase a.c. circuits.		
	16965.2.e	Apply the applications of power factor correction.	5	Apply capacitors in power factor correction.
C	16965.1.d	Describe the concepts of characteristics of three phase alternating supplies.	7	Demonstrate understanding of the nature and application of three phase sinusoidal alternating currents.
	16965.2.b	Apply the network analysis of voltage, current and power in three phase a.c. circuits.		
D	16965.1.f	Describe the concepts of properties and performance characteristics of an electric motor, generator and single phase transformer.	1	Explain operation of a simple dc motor.
	16965.2.c	Apply the analysis and simple configurations of motors and generators.	2	Explain operation of a simple dc generator.

E	16965.2.d	Apply the analysis and simple configurations of transformers.	8	Demonstrate understanding of the theory and application of single phase transformers.
F	16965.1.e	Describe the concepts of non sinusoidal waveforms and their characteristics.	6	Demonstrate an understanding of the nature of non-sinusoidal waveforms.
	Unit Standard 16968 Outcomes		**Dip Tech ECTE402 Outcomes (cont)**	
G	16968.1.f	Describe the operating and performance characteristics of passive filters.	10	Describe and apply the operating and performance principles of passive filters.
H	16968.2.b	Apply circuit analysis to network analysis of voltage, current and power in alternating current (a.c.) signal circuits.	9	Apply network theorems.

APPENDIX I

DETERMINATION OF LEARNING OUTCOMES FOR DIGITAL ELECTRONICS COURSE

Content of Unit Standard 16966 - Digital Electronic Concepts

element 1

Describe digital electronic concepts.

Range: concepts - characteristics of logic and digital numbering systems; characteristics of two current logic families; structure and operation of combinational logic circuits; structure and operation of simple asynchronous sequential logic circuits; structure and operation of a simple microprocessor system; operation of a bus; characteristics of assembler language.

performance criteria

1.1 The description provides a coherent statement of the concepts.

Range: description includes - main features, purpose, use of concepts.

1.2 The description identifies the characteristics of associated scientific rules, logic, and formulae.

1.3 Supporting practical examples provide valid illustrations of the concepts.

element 2

Apply digital electronic concepts in given applications.

Range: applications - selection and application of devices from a logic family; use of a combinational logic circuit; use of a simple asynchronous sequential logic circuit; conversions between and operations on two number systems; application of microprocessor to control simple processes; use of logic gates, truth tables, counters, and shift registers in given applications.

performance criteria

2.1 The selected principles, rules, formulae, and data are appropriate for the application requirement.

Range: requirements include any of - tests, experiments, problems.

2.2 The application process demonstrates valid and logical use of the technology concepts, rules, formulae, and data.

Range: processes include any of - mathematical or logical manipulation, computation, presentation.

2.3 The application results reflect valid use, or interpretation, or adaption of the technology concepts and formulae.

Range: results include any of - the behaviour, properties of systems equipment, components, materials.

Unit Standard elements disassembled into specific learning outcomes

element 1

Describe digital electronic concepts…

a. Describe the characteristics of logic and digital numbering systems.

b. Describe the characteristics of two current logic families.

c. Describe the structure and operation of combinational logic circuits.

d. Describe the structure and operation of simple asynchronous sequential logic circuits.

e. Describe the structure and operation of a simple microprocessor system.

f. Describe the operation of a bus.

g. Describe the characteristics of assembler language.

The description should…

performance criteria

1.1 Provide a coherent statement

1.2 Identify characteristics

1.3 Be supported by a valid illustration

element 2

Apply digital electronic concepts in given applications.

a. Apply the selection and application of devices from a logic family;

b. Apply the use of a combinational logic circuit

c. Apply the use of a simple asynchronous sequential logic circuit

d. Apply the conversions between and operations on two number systems

e. Apply the application of microprocessor to control simple processes

f. Apply the use of logic gates and truth tables in given applications

g. Apply the use of counters, and shift registers in given applications

The application should demonstrate…

performance criteria

2.1 Appropriateness of principles/rules/formulae/data through tests, experiments or problems

2.2 Valid and logical use of concepts/rules/formulae/data through manipulation, computation or presentation

2.3 Valid use or interpretation or adaptation of concepts and formulae through behaviour, properties, components or materials.

Final List of Outcomes for Digital Electronic Concepts (Unit Standard 16966)

	US	**Assessment Criteria**
	16966.1.a	Describe the characteristics of logic and digital numbering systems.
	16966.1.b	Describe the characteristics of two current logic families.
	16966.1.c	Describe the structure and operation of combinational logic circuits.
	16966.1.d	Describe the structure and operation of simple asynchronous sequential logic circuits.
	16966.1.e	Describe the structure and operation of a simple microprocessor system.
	16966.1.f	Describe the operation of a bus.
	16966.1.g	Describe the characteristics of assembler language.
	16966.2.a	Apply the selection and application of devices from a logic family;
	16966.2.b	Apply the use of a combinational logic circuit
	16966.2.c.	Apply the use of a simple asynchronous sequential logic circuit
	16966.2.d.	Apply the conversions between and operations on two number systems
	16966.2.e.	Apply the application of microprocessor to control simple processes
	16966.2.f.	Apply the use of logic gates and truth tables in given applications
	16966.2.g.	Apply the use of counters, and shift registers in given applications
Plus		*Content of Unit Standard 16968 - Circuit Analysis*
	16968.1.h	Describe the operating and performance characteristics of power switching regulators.
	16968.1.i	Describe the operating and performance characteristics of digital to analogue and analogue to digital convertors.
	16968.2.h	Apply circuit analysis to digital to analogue and analogue to digital convertors.

Outcomes for Digital Electronics (ECTE403) combined with Unit Standard 16966 / part 16968

Topic	Unit Standard 16966 Outcomes		Dip Tech ECTE403 Outcomes	
A	16966.1.b	Describe the characteristics of two current logic families.	1	Select and apply devices from common logic families.
	16966.2.a	Apply the selection and application of devices from a logic family;		
B	16966.1.c	Describe the structure and operation of combinational logic circuits.	2	Design and prototype a combinational logic circuit to solve a simple control problem.
	16966.2.b	Apply the use of a combinational logic circuit		
	16966.2.f.	Apply the use of logic gates and truth tables in given applications		
C	16966.1.d	Describe the structure and operation of simple asynchronous sequential logic circuits.	3	Design and prototype a simple asynchronous sequential logic circuit.
	16966.2.c.	Apply the use of a simple asynchronous sequential logic circuit		
	16966.2.g.	Apply the use of counters, and shift registers in given applications		
D	16966.1.a	Describe the characteristics of logic and digital numbering systems.	4	Perform conversions between, and operations on, binary, hexadecimal and decimal numbers.
	16966.2.d.	Apply the conversions between and operations on two number systems		
E	16966.1.g	Describe the characteristics of assembler language.	7	Write simple assembler language programs to control simple I/O devices.
	16966.2.e.	Apply the application of microprocessor to		

		control simple processes		
F	16966.1.e	Describe the structure and operation of a simple microprocessor system.	5	Describe the organisation of a simple microprocessor system and explain its operation.
	16966.1.f	Describe the operation of a bus.	6	Demonstrate understanding of BUS operation.
	Unit Standard 16968 Outcomes		**Dip Tech ECTE403 Outcomes**	
G	16968.1.h	Describe the operating and performance characteristics of power switching regulators.	8	Describe the operating and performance characteristics of power switching regulators.
H	16968.1.i	Describe the operating and performance characteristics of digital to analogue and analogue to digital convertors.	9	Describe the operating and performance characteristics of analogue to digital converters (ADCs) and digital to analogue converters (DACs)
	16968.2.h	Apply circuit analysis to digital to analogue and analogue to digital convertors.		

APPENDIX J

DETERMINATION OF LEARNING OUTCOMES FOR ANALOGUE ELECTRONICS COURSE

Content of Unit Standard 16967 - Digital Analogue Concepts

element 1

Describe analogue electronic concepts.

Range: concepts - characteristics and operation of two terminal and three terminal semiconductor devices; function and main parameters of an operational amplifier.

performance criteria

1.1 The description provides a coherent statement of the concepts.

Range: description includes - main features, purpose, use of concepts.

1.2 The description identifies the characteristics of associated scientific rules, logic, and formulae.

1.3 Supporting practical examples provide valid illustrations of the concepts.

element 2

Apply analogue electronic concepts in given applications.

Range: applications - application of semiconductor diodes in unregulated power supplies; general purpose operational amplifier configurations and applications; use of transistors in simple amplification and switching circuits and determination of impedances, biasing, gain/band width; direct current power regulators; system integration of above components.

performance criteria

2.1 The selected principles, rules, formulae, and data are appropriate for the application requirement.

Range: requirements include any of - tests, experiments, problems.

2.2 The application process demonstrates valid and logical use of the technology concepts, rules, formulae, and data.

Range: processes include any of - mathematical or logical manipulation, computation, presentation.

2.3 The application results reflect valid use, or interpretation, or adaption of the technology concepts and formulae.

Range: results include any of - the behaviour, properties of systems, equipment, components, materials.

Unit Standard elements disassembled into specific learning outcomes

element 1

Describe analogue electronic concepts.

a. Describe the characteristics and operation of two terminal semiconductor devices.

b. Describe the characteristics and operation of three terminal semiconductor devices.

c. Describe the function and main parameters of an operational amplifier.

The description should…

performance criteria

1.1 Provide a coherent statement

1.2 Identify characteristics

1.3 Be supported by a valid illustration

element 2

Apply analogue electronic concepts in given applications.

a. Apply concepts of semiconductor diodes in unregulated power supplies.

b. Apply concepts of general purpose operational amplifier configurations and applications.

c. Apply the use of transistors in simple amplification and switching circuits and determination of impedances, biasing, gain/band width.

d. Apply the use of transistors in simple switching circuits.

e. Apply concepts of system integration of above components.

The application should demonstrate…

performance criteria

2.1 Appropriateness of principles/rules/formulae/data through tests, experiments or problems

2.2 Valid and logical use of concepts/rules/formulae/data through manipulation, computation or presentation

2.3 Valid use or interpretation or adaptation of concepts and formulae through behaviour, properties, components or materials.

Final List of Outcomes for Analogue Electronic Concepts (Unit Standard 16967)

	US	Assessment Criteria
	16967.1.a	Describe the characteristics and operation of two terminal semiconductor devices.
	16967.1.b	Describe the characteristics and operation of three terminal semiconductor devices.
	16967.1.c	Describe the function and main parameters of an operational amplifier.
	16967.2.a	Apply concepts of semiconductor diodes in unregulated power supplies.
	16967.2.b	Apply concepts of general purpose operational amplifier configurations and applications.
	16967.2.c	Apply the use of transistors in simple amplification and switching circuits and determination of impedances, biasing, gain/band width.
	16967.2.d	Apply the use of transistors in simple switching circuits.
	16967.2.e	Apply concepts of system integration of above components.
Plus		*Content of Unit Standard 16968 - Circuit Analysis*
	16968.1.c	Describe the operating and performance characteristics of signal amplifiers.
	16968.1.d	Describe the operating and performance characteristics of operational amplifiers.
	16968.1.e	Describe the operating and performance characteristics of active filters.
	16968.1.g	Describe the operating and performance characteristics of power regulators.
	16968.2.c	Apply circuit analysis to amplifier gain and feedback.
	16968.2.d	Apply circuit analysis to single order filter analysis.
	16968.2.e	Apply circuit analysis to amplifiers.
	16968.2.f	Apply circuit analysis to operational amplifiers.
	16968.2.g	Apply circuit analysis to power regulators.

Outcomes for Analogue Electronics (ECTE501) combined with Unit Standard 16967 / part 16968

Topic	Unit Standard 16967 Outcomes		Dip Tech ECTE501 Outcomes	
A	16967.1.a	Describe the characteristics and operation of two terminal semiconductor devices.	1	Describe the operation, characteristics and basic application of various two terminal semiconductor devices. Apply semiconductor diodes to simple unregulated power supplies.
	16967.2.a	Apply concepts of semiconductor diodes in unregulated power supplies.		
B	16967.1.b	Describe the characteristics and operation of three terminal semiconductor devices.	5	Understand operation of BJTs and apply these in simple amplification circuits.
	16967.2.c	Apply the use of transistors in simple amplification and switching circuits and determination of impedances, biasing, gain/band width.		
C	16967.2.d	Apply the use of transistors in simple switching circuits.	6	Understand and apply BJTs and enhancement mode MOSFETs in switching circuits.
			7	Operation and uses of LEDs and Opto-couplers is investigated.
D	16967.1.c	Describe the function and main parameters of an operational amplifier.	4a	Describe the function of a general purpose op-amp and define its main parameters.
	16967.2.b	Apply concepts of general purpose operational amplifier configurations and applications.		
E	16967.2.e	Apply concepts of system integration of above components.	2	Understand the output / input relationship between voltage, current and power in a

	Unit Standard 16968 Outcomes		Dip Tech ECTE501 Outcomes	
				network.
F	16968.1.c	Describe the operating and performance characteristics of signal amplifiers.	9	Describe and apply the operating principles and characteristic components of a signal amplifier.
	16968.2.e	Apply circuit analysis to amplifiers.		
G	16968.1.d	Describe the operating and performance characteristics of operational amplifiers.	4b	Describe the function of a general purpose op-amp and define its main parameters.
	16968.2.f	Apply circuit analysis to operational amplifiers.		
H	16968.2.c	Apply circuit analysis to amplifier gain and feedback.	3	Understand and demonstrate the effect feedback has on the parameters of an amplifier and its relationship with stability.
I	16968.1.g	Describe the operating and performance characteristics of power regulators.	8	Operation of linear DC regulators is investigated.
	16968.2.g	Apply circuit analysis to power regulators.		
J	16968.1.e	Describe the operating and performance characteristics of active filters.	10	Describe and apply the operating and performance principles of active filters.
	16968.2.d	Apply circuit analysis to single order filter analysis.		

APPENDIX K

MARKING RUBRIC STUDENT HANDOUT

Diploma Marking Rubric / Scoring Schedule

Introduction

The following rubric or schedule has been produced to encourage the learning process, to provide a focus for documenting knowledge and to assist the performance assessment process.

Both achievement-based assessment and competency-based assessment are standard or criterion referenced, performance assessment. In other words, if you meet or perform satisfactorily against the standard or criteria, then you can be described as either having achieved or are competent against that performance criteria. Scoring a performance assessment usually involves making some subjective judgments about the quality of a student's performance. If the student does not know what the scoring guidelines are, or even if the scorer is hazy about such guidelines, the reliability of the assessment becomes questionable.

A rubric establishes a set of scoring guidelines to provide a way to make judgments fair and sound by setting out a uniform set of precisely defined criteria or guidelines used to judge student work. It will define levels of excellence and therefore help students achieve it, help students evaluate or assess their own and other student's work, communicate goals and help raters to be accurate, unbiased and consistent in scoring.

Scale Length

The length of the scale is the number of grades from a no response to a perfect response. In keeping with the MYTEC assessment policy achievement grades, this rubric has been developed with five categories corresponding to the possible final grades, with two extra categories – unanswered and a resit pass. Internally assessed responses not achieving a "C" or better will require a "resit" of that element of work.

The scale length of this rubric is 6.

A.	**Exceptional** (a response with no flaws)
B.	**Proficient** (a response with a minor flaw)
C.	**Acceptable** (a response with a few flaws)
D.	**Substandard** (a response with serious flaws)
E.	**Unsatisfactory** (a response that fails to progress)
F.	**Unanswered** (no response)
R.	**Resit Pass** (graded as Marginal after resit)

A grade of A, B, or C is considered as having demonstrated competence.

A grade of D, E, or F is considered as not yet demonstrated competence.

Scales

A scale is essentially a topic or focus for the assessment. The following topics have been identified as being those that are likely to be encountered while undertaking the various types of assessment. Topics are application, calculations/units, circuit diagram, communication, data record, elements of problem, graph/timing diagram/flowchart, list of equipment, mathematical/written reasoning, understanding, use of equipment, written description/explanation.

Using the Rubric

The grading concept contained within the rubric may be used or considered in two ways: holistically or individually.

Holistically, as in a short exercise… (holistic – adjective, chiefly "Philosophy characterized by understanding the parts of something to be intimately interconnected and explicable only by reference to the whole").

Individually, as in a laboratory exercise… i.e. a laboratory exercise may involve circuit diagram, data record, graph and use of equipment.

Holistic Scale

A Exceptional. Gives a complete (but not necessarily perfect) response and the student demonstrates an in-depth understanding of the task.

B Proficient. Gives a fairly complete response and the student demonstrating a good understanding of the task.

C Acceptable. Completes the task satisfactorily, and demonstrates an understanding of the major concepts even though the student overlooks or misunderstands less important ideas or details.

D Substandard. Begins the task appropriately, but either fails to complete or omits a significant part of the task, makes major errors, may misuse or fail to use appropriate terms or the response may reflect an inappropriate strategy for solving the task; i.e. the student demonstrates that there are gaps in his/her conceptual understanding..

E Unsatisfactory. Begins, but with an inappropriate response that suggests either no understanding of the task, the inability to attempt the task even when parts of the task are copied or a failure to indicate which information is appropriate to the task i.e. the answer may be totally incorrect or irrelevant.

F Unanswered.

Individual Scales

Application

A – clearly described a suitable application or made a clear extension to a more complicated application.
B – connected the solution to another application or extended the solution to a more complicated application.
C – made a general rule about an application.
D – incorrect application or incorrect reasoning for a possible application.
E – no substantial connection to any application.

Calculations/units

A – neat, clear and no errors
B – neat, clear with minor errors.
C – untidy with minor errors
D – untidy; difficult to follow; several errors.
E – very untidy; major errors.

Circuit diagram or Drawing

A – is neat, clear, correct and fully labelled.
B – is clear, correct and fully labelled but some untidiness.
C – is untidy but correct and fully labelled.
D – is incorrect or incomplete.
E – is incorrect and incomplete or misrepresents the problem situation.

Communication

A – effective with a clear and neat presentation.
B – effective with a clear presentation.
C – is correct but muddled.
D – does not communicate.
E – effective communication is non-existent.

Data record

A – raw data is clearly and accurately presented.
B – raw data is complete but untidy.
C – raw data is complete but some units and/or labels missing.
D – raw data is incomplete.
E – raw data absent.

Elements of problem

A – All-important elements of the task are clearly identified.
B – the most important elements of the task are clearly identified.
C – essential elements of the task are identified.
D – essential elements of the task are not identified.
E – no elements of the task are identified.

Graph/timing diagram/flowchart

A – are neat, accurate, labelled, keyed, and generated with software where possible.
B – are accurate with a minor omission and generated with software where possible
C – are correct and appropriate with a few omissions and may be hand drawn where generation with software is possible.
D – accurate but incomplete.
E – inaccurate and incomplete.

List of equipment

A – is neat, accurate and fully identifies (where possible) each item of equipment.
B – is neat, and accurate but does fully identify (where possible) each item of equipment.
C – accurate but is not neat and tidy and may not fully identify (where possible) each item of equipment.
D – tidy but incomplete and may not fully identify (where possible) each item of equipment.
E – incomplete and items of equipment cannot be identified.

Mathematical/written reasoning

A – is logical and explained thoroughly.
B – is generally logical.
C – basically correct but may contain flaws.
D – may be illogical, or it may contain numerous errors.
E – is illogical, and contains numerous errors.

Understanding

A – a concise understanding of the task's ideas and processes is demonstrated.
B – a clear understanding of the task's ideas and processes is demonstrated.
C – an understanding of the underlying ideas is demonstrated.
D – fails to demonstrate an understanding of ideas and processes.
E – no understanding of the task's situation is demonstrated.

Use of equipment

A – demonstrates confidence with use of equipment.
B – minor confusion over use of equipment.
C – some confusion but can take accurate measurements.
D – confusion and inaccurate measurements.
E – cannot use equipment.

Written description/explanation

A – is clear, coherent and unambiguous.
B – is reasonably clear.
C – is correct but muddled.
D – very muddled or has not been completed.
E – is not understandable.

APPENDIX L

SAMPLE OF ASSESSMENT INSTRUMENT – DC CIRCUITS TEST

Candidate's Name (....)

Diploma in Technology

DC Circuits – ECTE401/US16964

Test 1 A
Topic A, B, C & D

Time Allowed: 1 hour (plus 10 minutes reading time)

Electrical Concepts, Ohm's Law & Series / Parallel Circuits (24 marks)

Resistivity & Temp. Coeff. (18 marks)

Kirchoff's Laws (6 marks)

Instructions:

Carefully read 'Instructions to Candidates' on page 3 before commencing this test.

Total raw marks	48
Total Percentage of Coursework Marks	20 %

Useful Formulae

General

$$V = IR \qquad P = VI = I^2 R = \frac{V^2}{R} \qquad V_{OUT} = \frac{V_{IN} R_A}{R_A + R_B}$$

$$csa = \frac{\pi d^2}{4} = \pi r^2 \qquad R = \frac{\rho l}{a} \qquad W = \frac{1}{2} C V^2 = \frac{1}{2} L I^2$$

$$R_1 = R_0 (1 + \alpha_0 t_1) \qquad \frac{R_1}{R_2} = \frac{1 + \alpha_0 t_1}{1 + \alpha_0 t_2} \qquad \frac{R_1}{R_2} = \frac{1 + \alpha_3 (t_1 - t_3)}{1 + \alpha_3 (t_2 - t_3)}$$

Capacitance

$$C_T = C_1 + C_2 \qquad \frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} \qquad Q = VC$$

$$C = \frac{\varepsilon_R \varepsilon_0 a (n-1)}{d} \qquad \varepsilon_0 = 8.854 \times 10^{-12}\, Fm^{-1}$$

Magnetism/Inductance

$$\Phi = Ba \qquad F_M = IN \qquad F_M = \Phi R_M \ or \ F = \Phi S$$

$$R_M = \frac{l}{\mu a} \ or \ S = \frac{l}{\mu a} \qquad \mu_0 = 4\pi 10^{-7}\, Hm^{-1} \qquad \mu = \mu_R \mu_0$$

$$B = \mu_R \mu_0 H \qquad e = -N \frac{d\Phi}{dt} = -L \frac{di}{dt} = -M \frac{di}{dt} \qquad E = Blv$$

$$F = \frac{I_1 I_2 \times 2 \times 10^{-7}}{d} \qquad F = BIl \qquad F = \frac{B^2 a}{2\mu_0}$$

$$L = \frac{\mu_R \mu_0 N^2 a}{l} \qquad H = \frac{IN}{l}$$

Time Constant

$$T = \frac{L}{R} = CR \qquad v = V\left(1 - e^{-\frac{t}{\tau}}\right) \qquad V = V e^{-\frac{t}{\tau}}$$

$$i = I\left(1 - e^{-\frac{t}{\tau}}\right) \qquad i = I e^{-\frac{t}{\tau}}$$

Instructions to Candidates

- All working must be shown on this test paper.
- All work must be done in dark pen.
- Drawing of circuits and/or diagrams may be drawn freehand, but marking will take into consideration neatness of drawings.
- Marking will take into consideration neatness of calculations.
- Behavioural Objectives used in the questions have specific meanings as outlined below.

Objective	**Your answer should…**
Describe	Be a coherent statement of the concepts. Identify the characteristics of associated scientific rules, logic, and formulae. Have a supporting practical example(s) to provide a valid illustration of the concepts.
Apply *OR* Calculate	Demonstrate the appropriateness of the principles, rules and/or formulae. Demonstrate valid and logical use of the technology concepts, rules and/or formulae. Reflect a valid use, or interpretation, or adaptation of the technology concepts and formulae.

Summary of Assessment Scoring

Section / Part	***Number of individual grades***						*Resit Required*
	E	***D***	***C***	***B***	***A***	***A+***	
Section A Part 1							*Yes / No*
Section A Part 2							*Yes / No*
Section B Part 1							*Yes / No*
Section B Part 2							*Yes / No*
Section C Part 1							*Yes / No*
Section D Part 1							*Yes / No*
Weighted score	× *0.20*	× *0.45*	× *0.56*	× *0.70*	× *0.90*	× *1.00*	*Total Score*

Section A Part 2

Question 2 & 3
"Describe the properties of resistance in direct current (d.c.) circuits."
Minimum competency requirement is a proficient answer for ONE question PLUS an acceptable answer for the other question.

2. **DESCRIBE** the properties of resistance in a direct current (d.c.) circuit by describing how a change in resistance can change the voltage drop across that resistance.

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(1½ Mark) *E* *D* *C* *B* *A* *A+*

3. **DESCRIBE** the relationship expressed by Ohm's Law.

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(1½ Mark) *E* *D* *C* *B* *A* *A+*

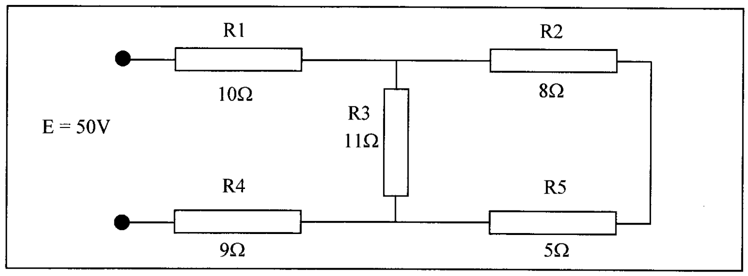
End of Part of Section

Series / Parallel Circuits

Section B   Part 1

Question 4 & 5
"Apply the analysis of voltage, current and power in d.c. circuits."
Minimum competency requirement is a proficient answer for ONE question PLUS an acceptable answer for the other question.

4. Refer to circuit diagram below and **CALCULATE**
   a) The total resistance of the circuit
   b) The power dissipated in resistor R_3.



Total Resistance ....

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Continued next page

Power dissipated in R_3 ....

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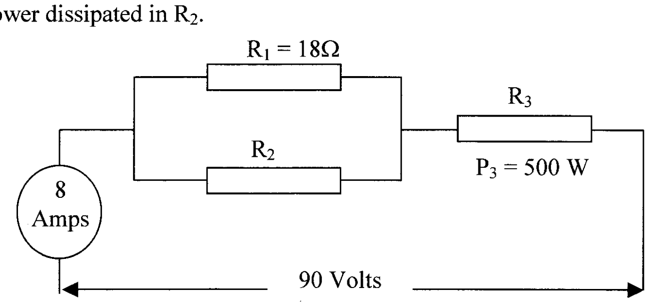
.... *(2 marks)*

(6 Marks) *E* *D* *C* *B* *A* *A+*

5. Refer to circuit diagram below and **CALCULATE**:
   a) Value of R_3.
   b) Value of R_2.
   c) Power dissipated in R_1.
   d) Power dissipated in R_2.



Value of R_3 ....

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.... *(1 mark)*

Continued next page

Value of R_2 ....
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.... *(2 marks)*

Power dissipated in R_1 ....
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.... *(1½ marks)*

Power dissipated in R_2 ....
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.... *(1½ marks)*

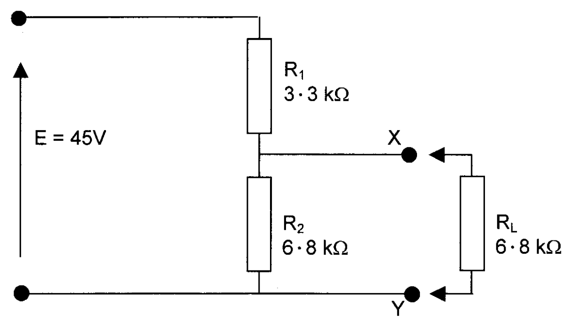
(6 Marks) *E* *D* *C* *B* *A* *A+*

End of Part of Section

Section B Part 2

Question 6, 7 & 8
"Apply the applications of voltage dividers."
Minimum competency requirement is a proficient answer for ONE question PLUS an acceptable answer for another question.

6. Refer to the circuit below which is being used to supply a reduced voltage for a load:



a) **CALCULATE** the voltage between X and Y **without** R_L connected.

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(2 marks)

b) If R_L is **now connected** to the circuit, **DESCRIBE** what would happen to the potential difference between X and Y.

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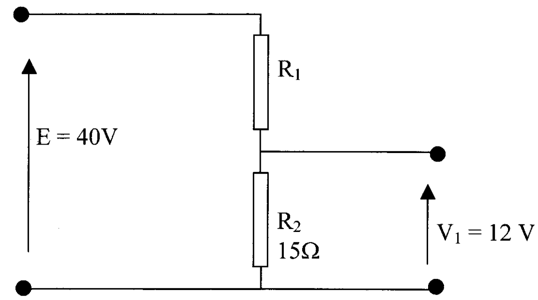
(1 mark)

(3 Marks) *E* *D* *C* *B* *A* *A+*

7. Refer to the voltage divider circuit below, which has an output voltage of 12 volts from a 40 volt supply.



a) **CALCULATE** the value of R_1 to give an output voltage (V_1) equal to 12 volt.

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(2 marks)

b) If a load (resistor) was connected to the 12 volt output, will the resistance of R1 have to be increased or decreased to correct the output voltage back to 12 volts.

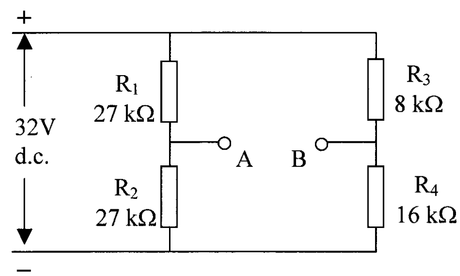
R_1 resistance is increased R_1 resistance is decreased

(Circle the correct answer)

(1 mark)

(3 Marks)   *E*   *D*   *C*   *B*   *A*   *A+*

8. Refer to the circuit diagram of a Wheatstone bridge shown below and **CALCULATE** the potential difference between terminals A and B.



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(3 Marks) *E* *D* *C* *B* *A* *A+*

End of Part of Section

NOTE: Test continues with a similar layout.

APPENDIX M
SAMPLE OF ASSESSMENT INSTRUMENT – DC CIRCUITS LABORATORY EXERCISE

Please print your name clearly here... (........................)

Direct Current Circuits

(ECTE401 / US16964)

Voltage, Current And Time In An RC Circuit

(Laboratory Exercise 9 –Simulation)

Aim:

1. Apply the behaviour of voltage and current in mixed networks of resistance and capacitance.
2. Investigate the charge/discharge relationship between voltage and time in an RC circuit.
3. Demonstrate understanding of the relationships between current, voltage and time when a capacitor is charged/discharged in a simple RC circuit.

Laboratory Exercise

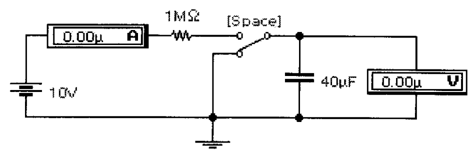
- *Note that work done in the laboratory counts towards the coursework mark - refer to the course information booklet.*
- This exercise has been completed and marked. (A requirement before you proceed to the next exercise). ✓
- All work has been completed neatly in dark pen. ✓
- All necessary information, working, calculations, equipment and measurement data has been neatly recorded. ✓

Tutor to initial when exercise is completed to a competent standard. [ ]

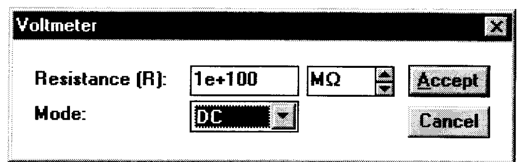
Requirements and/or Suggestions...

1. Investigate the time constant of an RC circuit.
(This exercise is best done in a small group)

a. Set up a simulation exercise as shown below. The circuit uses a switch activated by the space bar – in the position shown it will ensure that the capacitor is fully discharged.



b. Set the resistance of the voltmeter as follows to ensure that the voltmeter does not place a load on the circuit.



c. Prepare a table (for your **Data Record**) with three columns (time, measured voltage and measured current) and sufficient rows to allow the current and voltage to be measured at an interval of time of 20 seconds (i.e. 0.5 time constant) up to 5 time constants.

d. Select activate to commence simulation, and then start the timer at the same time as the switch is closed. Record the voltage and current at the required times.

e. Plot a **Graph** of the capacitor voltage and current against time (for the period of 5 time constants). Calculate the current that flows the instant the switch is closed and extrapolate the current back to zero time.

f. **Calculate** the voltage and current for times of 30sec, 60sec and 90sec and compare the calculated results with those measured from the graph.

Assessment Scoring

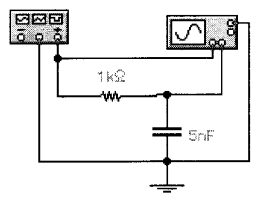
Data record	*2*	E	D	R	C	B	A
Graph	*4*	E	D	R	C	B	A
Calculations	*3*	E	D	R	C	B	A

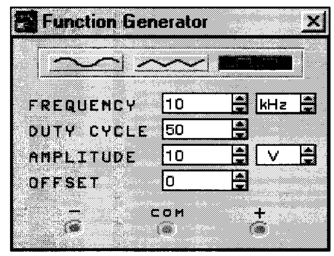
2. Investigate the effect of an RC circuit on a square wave.

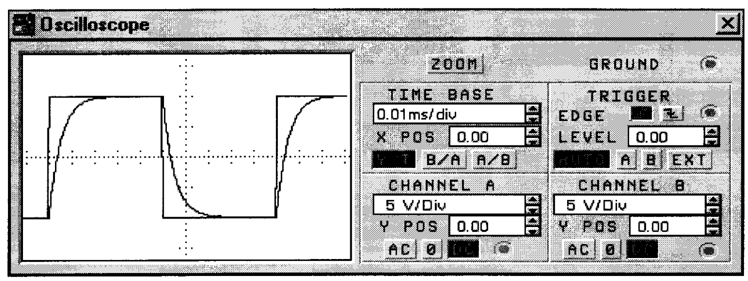
a. Set up a simulation exercise as shown below. The circuit uses a signal generator to produce a square wave and an oscilloscope to observe the square wave (input) and the capacitor voltage (output) waveform.

b. Set the signal generator and oscilloscope to match those shown in the pictorial views.

c. Activate the circuit and obtain the waveform as shown on the oscilloscope.



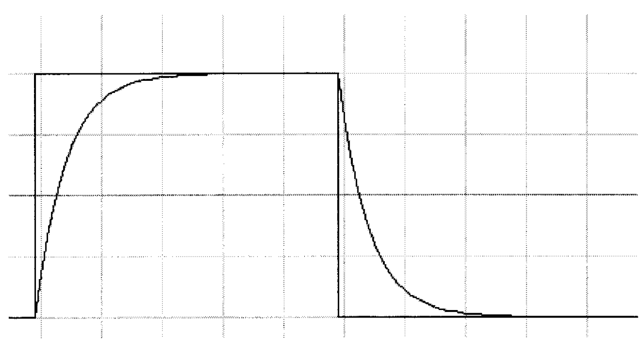




d. Deactivate the circuit, and then click on the ZOOM button on the oscilloscope.

e. On the larger view, drag the horizontal scroll bar along until you get a waveform similar to that shown.

f. Copy sufficient of the waveform to be able to paste an image of one cycle of the square wave into a document; e.g. …



g. Complete the **Graph** by labelling and scaling the axes and providing a suitable title.
h. **Explain** the shape of the output waveform in terms of the input square wave, the time period of the square wave and the time constant of the RC circuit.

Assessment Scoring

Graph	*2*	E	D	R	C	B	A

Written description/explanation	*2*	E	D	R	C	B	A

Summary of Assessment Scoring

	R	*C*	*B*	*A*	
Total number of individual grade weightings					
Weighted score for each grade weighting	× *0.50*	× *0.56*	× *0.70*	× *0.90*	*Total Score*

APPENDIX N
SAMPLE OF ASSESSMENT INSTRUMENT – DC CIRCUITS WRITTEN ASSESSMENT

Please print your name clearly here... (......................)

DIRECT CURRENT CIRCUITS
(ECTE401 – US16964)

Written Assignment #1

Due Week Beginning... **24-March-2003**

Coursework Marks... **7 %**

Assignment

Research and document a technical based report on the topic described below and related to the course learning outcomes. The documentation is expected to be coherent and descriptive written information on your topic and include relevant diagrams, illustrations, graphs, and/or sample calculations, etc.

Assignment Topic...

*(There are **TWO** parts to this assignment)*

Part A

Consider the following items to formulate your descriptive presentation (this does not mean that you just answer these as questions, it means that you prepare a written presentation using these items to guide you through the process) ...

1. Describe an electrostatic field (e.g. what is an electrostatic field, how is it formed, what electrical quantities need to exist, etc.?)
2. Describe a capacitor and draw the standard symbol (e.g. a 'capacitor' is usually the man-made object created to have a specific amount of capacitance, how may they be made, etc.?)
3. Describe capacitance C and state its symbol and unit (e.g. what is 'capacitance', does it exist only in a man-made capacitor, where does it exist, what is required for it to exist, etc.?)
4. Describe electric field strength and state its unit
5. Describe electric flux density and state its unit
6. Describe permittivity, distinguishing between ε_o , ε_r and ε

NOTE Items 1 to 8 in part A use the word **DESCRIBE**.

DESCRIBE means "to give an account in words including all the relevant characteristics, qualities, or events" and your assignment should demonstrate that ...

- The description is a **coherent** statement of the concepts.
- Characteristics of associated scientific rules, logic, and/or formulae are clearly identified.
- The concepts are supported by a (simple) practical example to provide a valid illustration.

Aim to write approximately 1000 words that should be done on a word processor Times New Roman (or similar) 12-point font, 1½ line spacing on A4 paper. The word processor will allow you to review your work and improve it over a period of time. Physical cut and paste of diagrams, etc. is acceptable as long as it supports your descriptive information and not just added to try to impress without understanding. Concentrate on spending your time researching, writing in your own words, and layout rather than hours at a computer trying to do fancy graphics.

If you use material from any source then you must acknowledge where your material came from so include a reference section at the end of the report. Don't just copy words from other material but try to write your own from an engineering perspective.

Part B

Apply mathematical techniques to complete the questions provided on the associted assignment **QUESTION PAGE** …

Note these questions require the use of the word **APPLY**.
APPLY means "to – bring or put into operation or use" and your answers to the questions should demonstrate …

- That the selected principles, rules, formulae, and data are appropriate.
- Valid and logical use of the technology concepts, rules, formulae, and data.
- Valid use, or interpretation, or adaptation of the (technology) concepts and formulae.

Calculations are to be neatly done by hand in a dark pen and clearly show the logical steps used to obtain the relevant information.

NOTE:

- Attach these sheets together with the Question Page to the front of your report with a single staple in the top left corner.
- Type/write on one side of A4 paper only.
- **DO NOT** place your report in a "fancy cover".

Marking Schedule

Refer to "Producing an Assignment" for the marking rubric.

Introduction	*10*	E	D	R	C	B	A
Discussion	*50*	E	D	R	C	B	A
Conclusion	*10*	E	D	R	C	B	A
Calculations	*20*	E	D	R	C	B	A
Format	*10*	E	D	R	C	B	A

Summary of Assessment Scoring

Total number of individual grade weightings	*R*	*C*	*B*	*A*	
Weighted score for each grade weighting	*x 0.50*	*x 0.56*	*x 0.70*	*x 0.90*	*Total Score*