CURTIN UNIVERSITY OF TECHNOLOGY

Science and Mathematics Education Centre

A STUDY OF THE MODELS AND TRENDS IN INFORMATION SCIENCE EDUCATION AND THEIR IMPLICATIONS FOR TAFE CURRICULUM PLANNING, COMPUTING LECTURERS AND LEARNERS

by
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Thesis submitted in partial fulfilment of the requirements for the degree of

Doctor of Science Education

at Curtin University of Technology.

January, 1997

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to the following group of people who all contributed to this project.

Firstly to Associate Professor Darrell Fisher, my supervisor, for his assistance, guidance and advice given at all stages of this project.

Next, my gratitude goes to the doctoral students for their constructive feedback when I presented this study during a Colloquium at the Science and Mathematics Education Centre at Curtin University.

My gratitude goes also to Catherine Milne, a colleague and doctoral student whose constant constructive criticism and patience in reading this project, enables the final thesis to have such a high standard.

Finally, recognition is extended to the students who so willingly participated in the development and evaluation of the survey.

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CHAPTER 1

INTRODUCTION

1. Background of the study

This study is concerned primarily with two Technical and Further Education (TAFE) courses in Western Australia (WA). These vocational and post compulsory courses consist of the professional stream (code 3500) and the Information Technology (IT) courses (code 9600 & codes 9614/15) which train computing professionals as project leaders, systems analysts and programmers.

From 1972 to 1994, course 9600 offered the Associate Diploma in Applied Science (Computing) award. This award ceased to take new students from the beginning of 1995. The two years fulltime course was based on the syllabi which listed in detail the material to be learned. This curriculum model was content driven and the syllabi were updated from time to time by curriculum planners responding to changes in the environment and to a rapidly changing technological workplace. This model emphasised the development of general vocational knowledge and the mastering of the content of the syllabi. It operated from the time of the Kangan Report (1974) and recommended a broad approach for the TAFE sector. Kangan stressed the development of the individual learner rather than directly matching employment requirements. Recently, Finn (1991) reaffirmed the importance of a general and vocational education approach by stressing the need for the development of underlying broad knowledge, interpersonal and problem-solving skills. An example of a syllabus is attached in Appendix A.

At the beginning of 1995, course 9614 started to offer the first year of the Diploma of Information Technology (IT) award which is based on the National Curriculum model. Students who complete the first year of the course, are awarded Certificate IV in IT. This is a uniform and standard course across Australia promoting pre-specified and observable skills as in Competency Based Training (CBT). The proponents of the CBT model emphasise solely job related activities. They claim that this model is more responsive to industrial and technological changes than the first model. Under pressure from employers to provide a responsive vocational education system, the Federal and State governments approved the creation of agencies such as the Australian National Authority (ANTA), the National Board of Training (NBT) and the Australian Committees for Training Curriculum (ACTRAC) to develop, implement and control the National Curriculum in Information Technology (IT). An example of a CBT curriculum is attached in Appendix B.

2. Research questions

The main research question of this study is to examine whether the content or the CBT curriculum driven model is more effective in terms of learners' satisfaction with aspects of their course and employers' requirements. For each of the curriculum models studied, there are two aspects of this main research question. The first aspect relates to the question of how the educational process impacts on learners and the second relates to the question of whether the model fosters transferable skills needed for the changing occupational environment.

The structure of the research questions, related to these models, is illustrated in the following tree diagram:

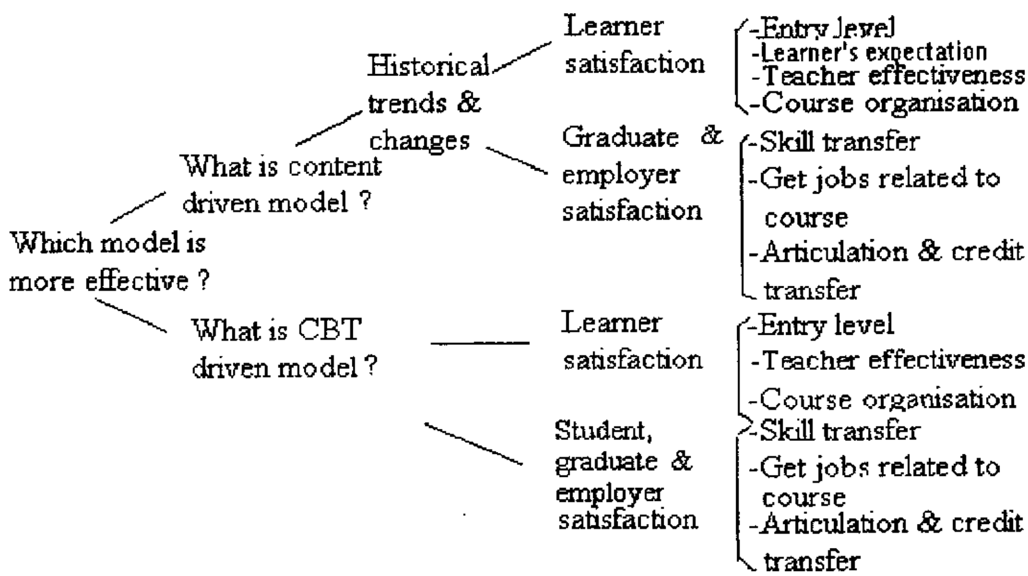


Figure 1.1. Structured research questions, pertaining to each model.

Since the content driven curriculum model was adopted by the sector for more than twenty years, an historical approach is appropriate for analysis of the influences that have occurred and how they have affected learners in obtaining jobs and transferring skills to meet employers' changing workplace environment. This historical account is not only based on facts but is placed in a framework of explanation, drawn from multiple discipline perspectives, in an effort to understand and improve educational practice in Information Science Education. This historical approach is helpful because it defines how various factors such as the learner's entry level, teacher effectiveness and course organisation had interacted and affected graduates' satisfaction with their course. Teacher effectiveness deals with factors such as teacher knowledge of the subject, teaching skills and ability to relate to learners. The question of course organisation deals with the following wide range of factors: educational goals, content mix and profile of syllabi, industrial relevance of the course, length of the units or modules, balance between theory and practice, delivery methods, adequacy of lecturer's notes, assessment types, equipment availability for practical skills and other learning resources. On the matter of graduates' satisfaction with aspects of their course, the research questions are to establish whether learners were adequately equipped and transferred their skills by adapting continuously to technological changes in the workplace.

On the other hand, the CBT driven curriculum model, recently introduced, has no historical data and therefore, this model is more difficult to assess, but the literature and research findings on CBT provide some guidance. As the current curriculum is based on pre-specified and observable skills only, the question is whether the CBT approach is too prescriptive and inhibits the learner's creativity to design information systems. In other words, does this model place too much emphasis on rote learning and the development of narrow technical skills and learning outcomes that fit only the computer at the expense of general and vocational courses? Does the CBT approach result in a learner's inability to resolve problems and transfer skills in order to adapt to technological changes? There are also other concerns such as articulation with other tertiary institutions, credit transfer, and whether CBT learners will be able to easily find jobs related to their course.

In comparing these two contrasting models, particular attention is paid to changes in learners' satisfaction levels between the content and CBT driven courses. Such changes as whether learners' satisfaction levels altered abruptly, temporarily or remained the same between the two models will provide additional guidelines about the choice of the appropriate curriculum model. Furthermore, the causes of these changes in students' satisfaction which occurred by moving from content driven to a CBT driven curriculum, are addressed.

3. Purpose and Significance

Global competition and major innovation in technologies are continuously affecting the nature of work in industry. The use of IT has grown in importance in society because information is needed by a variety of users for various purposes. Employers are demanding multiskilled people. The type of skills needed is shifting. As the work place and technologies change, the sector must continuously adapt courses to be relevant and responsive to changing industrial and technological needs.

Colleges help meet these needs by training people as computer professionals. As the workplace is continuously changing due to technological innovations, an adequate curriculum model needs to be adopted to update the course regularly, and to make it relevant to industry. Since Kangan (1974), there have been numerous reports on the desired directions and recommended training for lifelong recurrent education and a broad approach to technical and further education. Finn (1991) also reaffirmed a broad approach to technical education and stressed the need to promote interpersonal and problem-solving skills.

For more than twenty years, the sector adopted and operated a content driven curriculum model. However, recently the content driven curriculum model was replaced by the CBT curriculum model which emphasises a national and uniform approach based on job related activities.

According to the recent literature (Dede, 1989; Kings, 1990), there is a trend towards job related activities in education. The CBT model may in fact promote only narrow job related activities that fit only computers. Therefore, CBT may foster a narrow approach of learning-while doing through computers. However, there is evidence that the appropriate use of computers in the classroom is an effective and efficient learning tool (Green, 1980; Henderson et al., 1985; Salomon & Perkins, 1987; Hart & Lesquereux, 1988; Hesketh et al., 1988; Ely & Minor, 1993; Rowe, 1993; DEET, 1993a; Lee, 1994; Forman, 1994; Loss et al., 1994). However, there are concerns that the National Curriculum model is unduly emphasising specific and technical skills of little relevance, because this model uses a narrow approach to CBT at the expense of knowledge, values, attitudes and the way IT is used in the classroom. So, it is claimed that graduates in computing, entering the work force, may be unable to adapt, solve problems and innovate (Goldsworthy, 1993; Stevenson & Brown, 1994). In other words, the CBT curriculum is focusing too much on narrow technical skills to increase the rate of immediate responsiveness to changing employment and technological demands. Furthermore, by teaching only knowledge that fits solely a computer based system, the use of computers may change the teachers' role and the nature of their work. In this case, according to Bowers (1993), the teachers' role will be reduced to technical advisers. This study is therefore most timely and essential.

4. Research Methodology

4.1 Information processing model as a research framework

Since a curriculum model can be viewed as an information processing system which consists of inputs, processes and outputs (Richey, p.27, 1992), this study uses a system approach in comparing and evaluating the two contrasting curriculum models. Similarly, in a curriculum model, learners from different backgrounds undergo education and training through several pedagogical processes to gain knowledge, attitudes and relevant skills to obtain jobs related to their courses. If students' satisfaction levels with their course are not effective or if graduates do not match employers' requirements, the curriculum has failed and the model needs to be changed.

The groups of factors illustrated in Figure 1.2, are general to provide a direction for the study. They are the most appropriate as a system construct consisting of inputs, processes and outputs. This approach is favoured by Arrowsmith (1993 & 1994), NCVER (1993) and Dawe (1993).

Group 1 consists of factors such as learners' educational background and expectations before enrolling in the course. These factors relate to the highest qualifications obtained before the course and reasons for undertaking the course.

Group 2 consists of two sub-group factors:

- teacher effectiveness relates to knowledge of the course, teaching skills for the course and ability to relate to students; and
- course organisation relates to course content relevant to job, length of the units or modules, balance between theory and practice, availability of options, time and day classes offered, amount of contact with teacher, printed material and lesson notes, assessment methods, equipment for practical skills and library or learning resources.

Group 3 relates to graduates' employment status. It deals with the ability of graduates to gain jobs related to their qualifications in the areas of computing. Employment ratio can be calculated to measure the effectiveness of the quality of programmes in vocational education and training.

Group 4 relates to graduates' preferences for further studies. This deals with university accreditation for graduates who completed their studies.

Group 5 relates to demographic profiles of graduates. These factors provide information about the age, gender and whether students are local or overseas. It also gives an indication on their ethnic background and whether they found jobs in Australia.

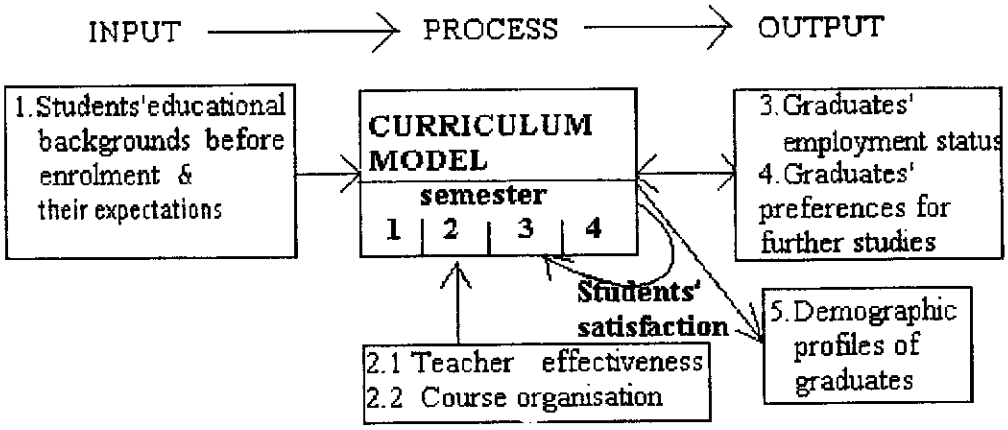


Figure 1.2. Example of a curriculum based on an Information Processing Model (source: modified and adapted from Richey, p.27, 1992).

Figure 1.2 adapted from Richey (1992), suggests a causal relationships model. This information processing model consists of five components which are seen as critical in this study. However, it is not a model which attributes learners' outcomes solely to teacher effectiveness. Since the same five experienced teachers are involved in teaching in both courses, teacher performance is expected to have a minimum impact on learning outcomes. There are three groups of input factors (1, 2.1 & 2.2) which influence output factors such as knowledge retention, attitudes to work and students' ability to obtain jobs related to their courses (3 & 4). These groupings are based on considerable research evidence to warrant a belief that these groups of variables affect learning outcomes.

(Richey, 1992). The fifth group of output factors relates to students' statistical information such as gender, ethnic background and whether they found jobs locally or overseas. Through surveys, students and graduates' satisfaction levels with their course are monitored. If students are not satisfied with their course and graduates cannot find jobs matching employers' requirements, the curriculum model is ineffective and needs to be restructured.

4.2 Research methods

A system approach is also applied in the evaluation of these two contrasting curriculum models as described in the previous section. Finally, different research methods such as observations, interviews, interpretation of official and educational documents and surveys are used depending on the types of problems investigated.

The rewinding of the clock to see " where we have come from" is useful. This approach leads naturally to the question of what should be preserved, and what should be modified or dropped. This approach also is used as a basis for addressing the issues of future and desired directions of the sector. These future directions should also be in line with the current literature and research findings related to Cognitive Science, Instructional Theories, Information Technology (IT) Education and Vocational Curriculum Models to provide theoretical explanations of these curriculum changes and their implications. Therefore, the historical account of curriculum changes is based on both the review of the literature and a wide range of material such as past and current surveys, and interviews. The historical account of changes in terms of the aims of the course, pedagogical approaches and major influences in the subjects, is based on College documents, syllabi, teaching guides, examination papers, type of computer equipment used, memos and several government recommendations reports (Kangan, 1974; Dormer 1983; Finn, 1991; DEET, 1990, 1992, 1993a, 1993b; NSW TAFE, 1992, 1993). Information related to pedagogical methods used in the classroom in the past 20 years, is based on informal interviews of the Head of Department of Accounting and Computing who worked in the sector for 30 years, and government survey reports (Arrowsmith, 1993 &1994; NCVER, 1993; Dawe, 1993). The National Centre for Vocational Education Research (NCVER) and the Department of Employment and Education and Training (DEET) survey on a regular basis the attitudes and concerns of students and graduates about the consequences of the implementation of the curriculum changes. Finally, the questions of the ability of graduates to adapt their knowledge to the changing employment situations and their satisfaction with aspects of the computing course are addressed through classroom surveys and interviews, and government survey reports on past graduates in their jobs.

In this study, the state of affairs of the National Curriculum implemented in Australia is analysed and various official reports and documents are examined and interpreted to understand how the different present peak committees such as the Australian National Training Authority (ANTA), the National Board of Training (NBT) and the Australian Committee for Training Curriculum (ACTRAC) interacted and worked together to provide a new direction over the Computing and Information Technology National Curriculum. ACTRAC is a committee set up to oversee that CBT courses are written in a specific format as illustrated in Appendix B (example of CBT curriculum). Students' satisfaction levels with the aspect of teaching effectiveness and course organisation of their CBT course, are based on surveys. The question whether the National Curriculum unduly emphasises narrow technical skills at the expense of general knowledge is examined. Answers to the other questions, on whether CBT learners are able to transfer skills and to adapt to the changing employment technological situations, are based on outcomes of surveys and interviews. Furthermore, the responses to these surveys and interviews are examined and interpreted through the use of the literature review and research findings. These findings are related to Cognitive Science, Instructional Theories, Information Technology (IT) and Science Education, and Vocational Curriculum Models.

Finally, when additional information is required, it is based on interviews with colleagues and experts in the areas of Information Science Education.

5. Outcomes of the study

This chapter provides an introduction to two contrasting vocational courses: the Associate Diploma in Applied Science (Computing) award, based on the content driven curriculum model and the first year Diploma of Information Technology award, based on the National Information Technology curriculum model. It develops the research questions pertaining to each model. It provides a full description of the present study and the adoption of a system approach in evaluating two contrasting curriculum models. Finally, this chapter justifies the study in terms of the significant impact the Information Technology has on society.

Chapter Two reviews the literature on the theories from different disciplines and research findings in order to guide the present study. This eclectic section discusses theories related to Cognitive Science, Instructional Theories, Information Technology (IT) and Science Education, and Vocational Curriculum Models.

Chapter Three describes the environment in which the content driven model has developed. It examines the historical changes and influences that have occurred in the Western Australian Technical and Further Education (WA TAFE) computing curriculum since its inception in 1970. It looks at the changes made in the curriculum and the syllabi in terms of educational goals, content mix and profile, and assessments' types. It investigates the relevance of the curriculum and the syllabi to meet the changing needs of industry; and assess the desirable and undesirable consequences of the content driven curriculum model.

Chapter Four evaluates the effect of the content driven model. It examines the degree of satisfaction of the graduates with aspects of their Associate Diploma of Applied Science (Computing) courses in 1991/2/3 based on the NCVER study (1993), Dawe (1993) and

Arrowsmith (1993/4) surveys. The results from each relevant question are provided, discussed and evaluated. This evaluation provides an in-depth view of graduates' educational backgrounds prior to enrolment in the course, their satisfaction levels of teaching effectiveness and course organisation, present employment status, their preferences for further studies and their demographic profile.

Chapter Five evaluates the current state of affairs under the new policy directions of the National Curriculum based on the CBT approach. Through classroom surveys, this chapter provides an evaluation of learners' degree of satisfaction with aspects of their Advanced Certificate IV of the National IT Curriculum. For comparison purposes, these surveys also provide information on students' educational backgrounds, level of satisfaction, their present employment status and preferences for further studies. It is most useful for curriculum planners, wanting to be cognisant in implementing a CBT driven curriculum model.

Chapter Six compares, evaluates and summarises the differences between the content and the CBT driven curriculum models. This chapter pays particular attention to the shifting of graduates' and students' satisfaction levels with their two different courses and the effects of moving from a content to a CBT driven curriculum model. It examines the changes in learners' satisfaction levels and explains the reasons of patterns of changes, given that learners' educational backgrounds, teachers' effectiveness and other factors have remained constant over the last five years. This comparison is useful for curriculum planners, computing lecturers and employers as it makes them aware of the strength and weaknesses of these two contrasting curriculum models.

Chapter Seven answers the question of the effectiveness of these two contrasting models. This has considerable implication for curriculum planners, computing lecturers and employers in terms of the ability of students to transfer skills and adapt to the rapidly changing IT environment. This study cannot predict the future, however, it makes long and short term recommendations for the sector based on historical evidence, research findings from the literature, surveys and interviews.

CHAPTER 2

LITERATURE REVIEW

1. Introduction

Those involved in the teaching of TAFE computing courses need to adapt to rapid technological and occupational change. Therefore, this chapter is concerned with a range of questions related to the internal and external effects on the processes of learning, the demand for skills, the impact of computers to foster problem-solving activities, trends in Information Technology and two contrasting models of occupational curriculum development. The review of the literature examines theories from different disciplines and research findings to guide curriculum planners. This section is organised in the following four areas:

- Cognitive Science;
- Instructional Theories;
- Information Science Education; and
- Vocational Curriculum Models.

2. Cognitive Science

The discipline of Cognitive Science is concerned with cognitive activities that are the internal processes of learning. Some theorists emphasise the use of memory, others the importance of problem-solving procedures and strategies. This section looks at the contribution of different information processing models on how students learn and solve problems. Furthermore, Cognitive Science provides guidance on where and how computer programming should be used to enhance learning and foster problem-solving skills. It examines the impact of programming instructions on intellectual development and transfer of high level skills under appropriate teaching conditions.

Several cognitive psychologists have turned to information processing theory in order to understand how students learn and solve problems. In studying cognitive activities, some psychologists emphasise the importance of cognitive structure while others emphasise cognitive processes and strategies in problem-solving. Information processing theory plays an important role in the education of IT professionals. They must be able to develop solutions to business problems and are essentially problem-solvers. Problem-solving skills play a critical role in training project leaders, systems analysts and programmers (DEET 1992, p. 46). Therefore, IT educational programmes need to be developed in such a way as to foster learners' problem-solving activities. To solve business problems, IT professionals need a rich cognitive structure emanating from different disciplines such as Accounting, Business Systems, Computer Science, Economics, Mathematics, and Psychology. In addition, when they develop new information systems, they must be able to plan, design and implement systems which require to select the adequate strategy (e.g.

sequential access of the information) and develop the appropriate processes to obtain the correct results. Therefore, knowledge structure and processes play an important role for IT professionals to perform their job successfully.

Cognitive Science has suggested different information processing about problem-solving. When students have difficulties in solving problems on the computer, it is important that teachers know what information gaps students have in their knowledge base. Knowledge bases are basically made of cognitive structures and processes, therefore, the following two types of models will be examined:

- the "cognitive structure" model which stresses the importance of Long Term Memory (L.T.M.). (The IT professional needs an appropriate level of knowledge structure); and
- the "cognitive processes" which emphasises the importance of procedures and strategies. (The IT professional needs a step by step approach to solve problems and produce the correct results).

2.1 The cognitive structure model

This type of model, proposed by Romberg and Carpenter (1986), assumes that cognitive structure is most important because all the facts, concepts and rules required in problem solving, are stored in human memory. Knowledge is represented in human memory as semantic networks called schema. A schema consists of a network of concepts which enables interrelations of elements of information about a topic. A schema, which is a data structure, may represent concepts, functions or rules. In computer science, data structure techniques are used in file organisations to create and retrieve information from memory. Schemas represent concepts applicable to objects, situations, events, sequences of events, actions, sequences of actions. So facts, concepts and rules are kept in human memory as information organised in a structure. Romberg and Carpenter stressed the importance of determining how students try to link new information with what they already knew. Therefore, the authors argued that it is necessary first, to understand how information is organised in the L.T.M., and then find out how the information is connected to what is already in the learner's L.T.M. if the researcher wants to understand how something is learned. Therefore, the initial knowledge in the learner's memory has to be mapped together with the set of procedures that the learner uses in problem-solving (e.g., a top/down approach to problem-solving).

Kempa and Nicholls (1983) reported that learners at more advanced levels have a complex network of schemas integrating more elements for a given problem. They stressed that the problem-solving weaknesses of poor problem-solvers are attributed primarily to their knowledge in their L.T.M. rather than to their lack of problem-solving skills. They said that good problem-solvers have a more complex semantic network than the poor problem-solvers. The strength between concepts seems to be less intense in the mind of poor problem-solvers because they probably do not have a good grasp of the concepts. Poor problem-solvers show gaps in their cognitive structure because they store, in their L.T.M., concepts related to the lower levels of abstraction (e.g. description of the concept). Kempa and Nicholls seemed to over-emphasise the importance of cognitive structure or memory factor in problem solving. In addition, they assumed that there is a correlation between achievement and a rich memory. They explained problem-solving activities in terms of functional relationships and not in terms of activities which are mental processes. They assumed that the learner's schema or knowledge in memory will stay static and does not change over time.

Information processing theorists such as Ausubel (1968) explained problem-solving activities in the following way. New information is stored in L.T.M. as one or more schemas which were formed by previous learning situations. A schema not only helps retention of what is learned but provides a framework for new information to be accommodated into the learner's existing schema. If new pieces of information can be integrated into the learner's existing cognitive structure then that information becomes meaningful to the learner. If, however, the learner cannot integrate (Ausubel used the term "subsume") the new information into his existing cognitive structure then only rote learning will occur which is not meaningful. Any learning occurring under these circumstances will be "parrot fashion" and quickly forgotten. However, it may sometimes happen that a topic is learned in a rote fashion at the initial stage and become meaningful later. Existing schemas can also change as new information is learned. Learners will make further changes to their schema. If this new information cannot fit into their existing schema they will become frustrated and meaningful learning will not occur. Facts and concepts are thus not only kept in the learner's L.T.M. as a random heap of discrete units but as information organised into a structure which will change over time.

Simon (1979) reported that E.A. Feighenbaum, after simulating a game between experts and normal chess players, found experts could remember more events and reconstruct more positions when they look at the chess board. Simon suggested that the nature of expertise in playing chess or performing similar tasks is the amount of pieces of information that experts can store and retrieve from their L.T.M. Simon explained that problem-solvers process information in retrieving and using information from the L.T.M. to be used in working memory together with recently received information. After the result new information may be stored back into L.T.M. This is called high level thinking. Cognitive activities utilising only recently received information represent lower level thinking. Cognitive activities utilising L.T.M. also represent higher level thinking. This process described by Simon is also a typical approach used in the field of Computing and Information Technology. In programming, for example, students are forced to process new information with old ones already stored in their memory. By repeating these cognitive operations several times and iteractively, students learn. Programming is in fact an appropriate way to force students to recall all that they have learned and consequently promote higher level of thinking.

Cohen (1981) suggested that in mastery learning students cannot fail. He said that failure is truly constricting and destructive to the students. He suggested that in order to understand why learners behave in a certain way, it is important to explain their behaviour in terms of the kind of information that learners have stored in their L.T.M.

The Stahl information processing model (Stahl, 1979; 1987) was based on Cohen's research work and the time factor. Stahl emphasised a learning theory based on continually retrieving information from the L.T.M. in order to promote retention and building up student's own belief. He argued that the person's information base which is stored in the L.T.M. plays an important role when students processes information. He pointed out that information received by the learner during the classroom period, is learned only when it is retrieved from L.T.M. Furthermore, Stahl stressed the importance of the time factor in the learning process. He stated that learning occurs only when the learner can apply tasks or activities which were given 23 hours or more earlier in a lesson. That time period of 23 hours or more is important because students at the end of the lesson period lose 70 to 90% of the information which they received during the lesson. For example, application of principles or rules can only be demonstrated by students if they can directly use these principles, or rules, 23 hours after the material was taught. An important aspect in the Stahl model is the fact that learners continually use their L.T.M. If the instruction timing is planned correctly, computer programming forces students to continually apply all the material they have learned previously. In addition, they are influenced by information from their own cognitive Belief System. In other words, the information the learners have in their L.T.M., is used to guide or dictate them to make decisions and finally alter their behaviour. This concept of "Belief" is relevant to teachers because students are influenced in their acts by their past experiences which may have been successful or not. To make decisions, students require to access their Information or Knowledge Base. If they have gaps in their Information or Knowledge Base, they will make the wrong decisions or give an incomplete answer to the problem. The Stahl model proposes, therefore, a clear framework to IT curriculum planners and teachers: time factor in the learning process is important for students to build an adequate Knowledge or Information Base in their L.T.M. If students fail too often in their examinations, they will lose confidence which will reduce their chances of success. The Stahl model also proposes a clear framework of balanced assessments (e.g. students are discouraged if they believe that the examinations are too hard) and to use this in the classroom situation.

2.2 The cognitive process model

The other types of models of information processing in problem-solving are more dynamic and complex in nature. These models assume that the problem solving activities operate as computer programs (Sutton, 1980). Computer programs need a set of procedures to process input and produce output information which are stored in memory. When students solve problems their mental activities operate by performing the same steps of a computer program (understand the problem, decompose the problem into smaller tasks, plan a solution, code the program, test and verify the expected results). Here, computer programming can play an important role in promoting process or problem-solving skills.

Simon (1979) stressed that problem-solvers need not only a set of procedures, but several strategies in order to find an efficient solution to the problem. Students can be trained in these different procedures and acquire problem-solving strategies. They can gain practice in problem-solving and learn problem-solving principles.

The W.A. Educational Consortium (1983) suggested the creation of tasks which are content free software programs to foster problem-solving skills. The Consortium argued that this type of program which is called a heuristic tutorial, helps students to discover by trial and error a strategy in order to solve the problem. The Consortium also recommended the integration of computing into the curriculum and suggested that computer software be used to facilitate learning. Therefore, in the programming area, students ought to manipulate data or ideas by using software programs such as a SQL database software product or programming languages such as PASCAL etc. Simulations are also valuable learning tools and they are effective and efficient in teaching a wide variety of subjects (Moore and Thomas, 1983). Evidence shows that the use of computers enhances cognitive activities (Patterson and Smith, 1986) and computers in the classroom make a positive difference in learning (Okey, 1985). Therefore, the use of computer programming is an appropriate teaching aid to present and exemplify concepts, rules and principles, and to develop algorithms.

2.3 Impact of computer programming on cognitive activities

Jones (1986) stressed the importance of understanding cognitive processes involved in programming. Once the learning process is known, the teacher can improve his strategy to facilitate learning. Green (1980) looked at problem-solving methodologies such as the top down design approach. In observing good programmers, he stressed that they work intuitively from a stepping stone to a stepping stone strategy in building programs.

Salomon and Perkins (1987) in investigating the impact of programming on the development of cognitive skills, argued that programming provides the opportunity to develop cognitive skills (e.g. rigorous thinking, precision, structural organisation of information, use of heuristics, nurture of self-consciousness about the process of problem solving etc..), and transfer those skills into other domains. They distinguished between:

a) "what" is transferred from programming. For example, procedural logic is required for programming and this cognitive skill may be transferred to other domains.
b) "how" transfer occurs. For example, how is procedural logic transferred to other domains. That means under which conditions can one predict transfer.

The transfer mechanism consists of what is called the "Low road transfer" and the "High road transfer". In the former transfer occurs when a student has reached near automaticity in one context and becomes activated spontaneously by stimulus conditions in a similar context. For example, programmers proficient in PASCAL may easily transfer their programming skills into another program language (e.g. programming C) to solve a similar problem. Low road transfer relates to concrete operations. The high road transfer involves abstracts operations. It consists of transferring problem solving skills from one context to a different context. Here, students are able to generalise and represent knowledge in symbols. Students require motivation, some degree of cognitive skills and make a substantial cognitive effort. Salomon and Perkins reported some interesting findings related to the transfer of programming skills into other fields. They pointed out that transfer occurs from programming to non-programming problem solving under the following specific conditions:

- students must reach advanced level of programming expertise; and
- students must be guided to solutions by the teacher.

In other words, transfer does not occur spontaneously. Furthermore, they reported that a group of students who completed two academic years of computer science courses involving programming had no better achievement than another group who received none or little programming instructions. Except, that the programming group achieved better results in the area of algorithm design only. For programming skills to foster planning skills, Salomon and Perkins suggested that the activity must be supported by an appropriate teaching strategy. Furthermore, to facilitate "high road" transfer the following conditions and teaching strategies are necessary:

- high teacher/student ratio;
- high question and answer interaction with the learner;
- teacher understanding of student's needs in terms of information base they require in order to complete their design and computer programs;
- ability of teacher to provoke abstraction and use of symbolic representation (e.g. use of pseudocode, charts or diagrams);
- students moving constantly from coding to design and vice and versa; and
- linkage to student's experience and connection making.

Curriculum planners and teachers must be aware that these transfer skills mostly are related to strategies such as planning skills (e.g. breaking down the problem into parts, planning a solution), diagnosing (e.g. encountered in medicine) and debugging (e.g. finding the programming logical and coding error).

Salomon and Perkins also pointed out that programming generates ideas among the novice programmers. It also encourages the representation of ideas into programming codes, testing of their ideas and correction. They reported that a one year "Introduction in Computer Programming" does not foster any transfer. Even two years of conventional programming instruction does not always foster "low road" transfer. Transfer will only occur when the "high road" is forced and the students are helped to think about programming at an abstract level. For example the use of higher cognitive activities such as logical and symbolic notations will stimulate higher level thinking and facilitate transfer.

Mastery of programming languages does not foster "high road" transfer, since strategies and principles may transfer by abstraction.

Cognitive theorists such as Flavell (1979) and Brown (1982) suggested the use of a process-oriented (instead of content-orientated) approach as a teaching strategy to promote problem-solving skills (e.g. planning, analysis, monitoring and evaluation). They stated that there is evidence that metacognitive training can help students to develop problem skills and transfer them into other contexts. Metacognition refers to processes whereby learners reflect on their own thinking and procedures in solving problems. In this teaching strategy, teachers set the activities (e.g. a skeleton program with missing lines) in which the students exercise their thinking processes. Teachers ask questions and never provide answers but encourage learners to discover and discuss the reasons and the ways they arrived at the solution. In this case, it means that teachers focus on the method rather than the task-specific skills such as the usage of PASCAL programming instructions or features and the syntax of the language.

When students have difficulties in solving problems on the computer, teachers need to know what gaps in terms of information structures, processes and strategies students have in their knowledge base. There are useful techniques which can help the teacher to explore the students' mind in order to find out where they have difficulties and this is discussed in the following section.

2.4 Need to understand problem-solvers' minds

To understand how problem-solvers resolve problems, their minds must be explored and different and useful techniques for mapping such information are available. Each of these methods may be used alone or in conjunction with other techniques. The choice of one or more of these techniques will depend on the researcher's belief and the research design. If researchers believe that memory plays a major part in problem-solving, they will choose declarative methods. However, if they believe in cognitive processes and strategies they will use protocol analysis. Stewart (1980) classified the various exploration techniques into two distinct categories:

- declarative methods (knowing what) which describe what the learner knows; and
- procedural methods (knowing how) which describe how the learner arrives at the solution of the problem.

These two categories are described in the following sections.

2.4.1 Declarative techniques

Declarative techniques have some advantages but also some weaknesses. Techniques such as concept tree building tasks can be mapped easily on to paper. Tree building is used in structured design and programming to promote planning of the problem to be solved. In programming, tree building is in fact, a structured chart which forms part of the external documentation of a program. A structured chart help IT students to plan their problems and decompose them into smaller tasks. For example, charts are useful methods to represent the learners' cognitive structure but they provide only a static picture of their knowledge. These techniques assume that the learners' knowledge stay static over time and describe what the learners know. These types of exploration techniques are more suitable for the lower cognitive activities of problem-solving but are less suitable to use for exploring higher cognitive activities in problem-solving such as algorithm design.

2.4.2 Procedural techniques

Procedural techniques are used to explore cognitive processes for algorithm design and this is called protocol analysis.

Simon (1979) suggested that one of the best sources of data in observing problem-solvers is a verbal protocol because it is objective reproducible data and can be compared with theoretical models (computer simulated) and with empirical data. This methodology can be used to simulate human cognition.

Research findings in the area of protocol analysis (Rowe, 1985), indicated that this technique is useful for unfolding cognitive processes. Protocol analysis is the use of a 'thinking aloud' methodology which consists of asking problem-solvers to express aloud what they think. If the problem consists of a succession of logical events, the verbalisation of problem-solvers is recorded and analysed. The learners report problem solving activities (e.g. a strategy) rather than just a description of what is in their memory. Learners are encouraged and asked what they are doing, what they are searching for, what they plan to do with the information, if they hypothesise and so on. The major strength of this above technique is that during problem solving the researcher observes learners struggling with the task. This method has the advantage of showing whether students are using the wrong procedure. It can be used for long and complex design and programming tasks. Protocol analysis is easy to implement in the classroom and highly productive provided that the student is willing to cooperate.

Protocol analysis has some weaknesses because it will not include all the cognitive activities taking place in the learner's mind. Major arguments against the generation of data based on verbalisation only, is that words might have several meanings and therefore the above techniques are not objective because the data are incomplete, distorted and time consuming. This method can only be applied to small groups of students which is the case in most TAFE computing classrooms.

The next section of this chapter examines the importance of Instructional Theories.

3. Instructional Theories

Instruction is defined as a set of events external to the learner which is designed to support the internal processes of learning. Here, it is useful to refer to Gagné and Dick's (1983) research paper where they reviewed a number of Instructional Theories:

Caroll's Mastery Learning Model (reported in Gagné and Dick, 1983)

This instructional model is important because one needs time to learn programming skills and transfer these skills into algorithm design. This model also forms the basis of the Stahl (1987) instructional model. It emphasises the time required to learn, time the student is willing to spend in learning, time allowed for learning, student participation and remedial feedback in order to increase the quality of instructions.

Caroll (1963) stated this in the following model:

$$\text{degree of learning} = \text{function of} \left(\frac{\text{time actually spent}}{\text{time needed}}\right)$$

Time actually spent means time allowed for learning by the teacher. Time needed in learning, on the other hand, depends on the aptitude of the learner. High aptitude learners need a small amount of time, low aptitude learners need more time to learn. Time needed in learning is also dependent on the following two factors:

- the ability of the student to understand instructions (some students for example have more verbal/reading ability than others); and
- the quality of instructional material presented in the lesson by the teacher. This includes the way the various tasks are presented in order to facilitate learning.

It must be noted here that the school curriculum or the teacher allows less and less than adequate time for learning the tasks because very large amounts of material, which the teacher is expected to teach, are inserted every year in the curriculum. The same phenomenon happened in TAFE where more material was added every year in the syllabi.

Prescriptive theory

Merrill (reported in Gagné and Dick, 1983) emphasised immediate and correct feedback information and reward for correct performance has the largest overall effect on student learning (Fraser et al., 1987). Furthermore, Fitzgerald et al (1986) showed in a meta-analysis that students using computers achieved better results. For example, the less able people gained most, except for Mathematics where only the most able students gained most. Reinforcement had a large impact on achievement because of the overall feedback effect on the learning process and it is here that Computer Assisted Learning (CAL) can be appropriately used to provide immediate and correct feedback.

Elaboration theory

Reigeluth and associates (reported in Gagné and Dick, 1983) proposed an approach of starting from the general and then moving to the detailed but constantly going over the material. Repeating this sequence several times is designed to give the learner a more elaborate view of the topic. Here, programming is appropriate as students must integrate old information with new ones. By repeating these logical operations several times, students learn.

Management Factors

Rothkopf (reported in Gagné and Dick, 1983) identified factors which increase the probability of success of attaining a learning outcome. The emphasis is not only on the time variable suggested by Caroll (1963) but also on other management factors which provide the learner with a variety of forms of instruction (e.g., verbal, visual, use of sound).

Programmed Instruction

Markle & Tiemann (reported in Gagné and Dick, 1983) proposed a theory based on the concepts of high interactivity, "errorless" learning and immediate feedback. Here, the use of computers is again very appropriate. In programming the computer, students receive immediate feedback on their syntax errors but they are also forced to test their programs until they are free of logical mistakes.

Algorithmic Approach

Landa (reported in Gagné and Dick, 1983) stressed the use of algorithms to make instructions more effective. Here, the use of programming as a tool together with structured and Nassi-Schneiderman charts facilitate learning. These charts are used in computing not only to document programs but also as a planning and a teaching aid.

Merrill (reported in Gagné and Dick, 1983) emphasised mnemonic aids, use of algorithms, sequencing of the material into a ranges of difficulties and moving from goals to objectives to tests.

Instructional delivery

Richey (1992, p. 118-122) argued that preferences for delivery systems are similar for both adult and younger learners. He reported several research findings showing an overwhelming preference of learners for group instruction over individualised formats. Group instruction is preferred because they like the opportunity to meet with their colleagues in the classroom where they can interact frequently with peers. Individualised instruction relegates reinforcement to the instructional material. There is no opportunity for feedback and reinforcement from peers.

4. Information Science Education

Due to global competition and continual needs for the development of businesses, Boynton and Zmud (1987) argued that IT practitioners and information science educators must be brought together to determine appropriate educational programmes. Then, educators must continue to provide guidance based upon research and classroom experiences to develop an IT curriculum. Practitioners working in the industry must also be an integral part of the process through which IT programmes are created and maintained.

The next section examines trends in the industry's demand and supply for skills, course profiles in terms of goal, content, taught processes and technological innovations which are affecting the area of IT education.

4.1 Demand for skills

The curriculum committee of the Association of Computer Manufacturers (ACM) suggested that the demand for people with balanced skills is relatively much greater than the demand for solely technical or business skills (Nunamaker, 1981). The need, then, is for a curriculum which provides both technical and business systems skills.

Hartog and Herbert (1986) suggested a set of skills that Management Information Systems (MIS) managers commonly identify as important for IT professionals to possess. Certain of these skills are generally given priority when employing people. They are interpersonal skills (e.g. work effectively in a group) and general business skills (e.g. manage IT resources efficiently).

Table 2.1

What foundation skills do information managers value most in employees involved in information technology (Source: Crokett et al, 1993, p. 12)

Most important foundation skills valued by information managers	%
1. Sensitive to issues of quality	97
2. Gather Information to solve a problem	95
3. Work effectively within a group	95
4. Understand problems faced by end-users	92
5. Understand business concepts and apply them in problem solving	86
6. Present information to expert and non expert in a group settings	73
7. Use structured systems development methodologies	70
8. Write and present well organised formal reports	68
9. Experience with mainframe operating systems and utilities	58
10. Resolve interpersonal and organisational conflict	58
11. Educate end-users on the capabilities of software and hardware	57
12. Install and configure multi-user applications	50
13. Understand and apply data modelling concepts	44
14. Motivate and direct other people	35
15. Generate 4GL code	27
16. Apply CASE technologies to systems development	26
17. Develop cost/benefit analysis and end-user charging systems	25
18. Set up and manage LAN networks	24
19. Troubleshoot and repair minor microcomputer hardware problems	23
20. Program in Cobol	19

Table 2.1 depicts foundation skills valued most by information managers. The higher ranking business/interpersonal skills relate to quality of work (1); communications (2); able to work in a group (3); and general business concepts (4).

The lower ranking business/interpersonal skills relate to cost/benefit analysis (17), motivating and directing people (14), and resolving interpersonal or organisational conflicts (10). These may not be considered critical for a new employee because they are associated with managerial activities, and therefore could be cultivated as part of an organisation's employee development programme.

The technical skills that are ranked highly, are the general skills associated with development methodologies (7): for example, structured systems development, data modelling (13), and installation of multi-user applications (12). Knowledge about specific technologies, such as COBOL programming (20), micro computer hardware (19), CASE tools (16), and fourth generation languages (15) appears to be less important to the respondents than familiarity with various methods and approaches to the corporation of technology business.

Conclusions drawn from the responses to the survey appear to support the idea that the IT curriculum should emphasise the development of interpersonal and business skills over technical skills. The data do not indicate that technical skills are unimportant, but that some interpersonal and business skills ultimately carry greater weight. There are, thus, contradictions when educators claim that employers prefer new employees with advanced interpersonal and business skills, but the same employers screen job candidates based on a set of skills predominantly technical in nature. In summary, the IT graduates must have a base level of technical skills to be considered for a job, but they will also need business and interpersonal skills to prevail in a competitive market and to progress successfully once employed.

Crokett et al. (1993) suggested a combination of traditional curriculum development with a criterion-based approach which incorporates the most valuable skills. But, they suggested that a concept of market driven curriculum development is not necessarily the only valid approach for creating excellence in Information Technology education. However, obtaining and keeping a job will continue to be high on the priority list for graduates. In addition, locating and retaining quality IT employees will always be a critical goal for employers.

Goslar and Deans (1994) showed that the IT curriculum becomes more internationalised. Therefore, it is useful for curriculum planners to examine other models in different countries. The results indicated that there are similarities between European and USA IT programmes. Goslar et al. noticed similarities in content, trends and taught processes. They stressed also that systems analysis and design are consistently viewed as an important curriculum component for both the USA and European countries. The USA undergraduate programmes place an emphasis more on programming subjects while this is not true for USA graduates programmes. In their study, they reported that the majority of IT curricula contained the following components:

- Systems Analysis and Design, Database and Data Structures, Management Systems and Organisation Theory, Expert Systems, Programming, Communications and Networks, and hardware course

They reported the use of a full range of hardware from all the major suppliers. They reported also the use of a wide range of software application packages such as:

- Spreadsheet, Word Processing, Database, Graphics, Expert Systems, Decision Support Systems, CASE tools and Statistical Analysis.

Gorgone et al.(1994) stated that there are major shortcomings in the Association of Computer Manufacturers (ACM) curriculum which used a Information Systems or Computer Science approach. This dual approach has flaws in Information Science Education because the former offers an incomplete view of technology's role in management and the latter provides a narrow technical perspective on applications (e.g. programming). For Gorgone et al., an Information Science Education meant an integration into the curriculum of several common concepts/tools/techniques (e.g. system theory, symbolic representations, problem-solving strategies, scientific research, data modelling techniques etc.) from various disciplines. They proposed an interdisciplinary approach, drawing on such disciplines as the Arts, Accounting, Economics and Management, Computer Science, Engineering, Linguistics, Mathematics, Sociology, Philosophy and Psychology.

One approach recommended by the NBEET Report (1994, p. 111) to the development of Information Science courses that are neither too fragmented, nor too prescriptive, was the use of integrated curriculum. In an integrated curriculum subjects were linked horizontally across broad strands while they were developed in-depth. In the traditional curriculum, a whole field was explored incrementally according to established prerequisites (e.g. syllabus - Cobol 1, 2 and 3). Another approach to the development of courses was to introduce project modules which allow students to integrate various modules. This approach needs of course well qualified and experienced computing teachers who have gone through these activities several times. The NBEET Report provided some examples of a modern approach to course development. It claimed that some institutions had implemented a lifelong learning curriculum. The Bachelor of Computing of the University of Tasmania also based its model on the recommendations of the Report of the Discipline Review of Computing Studies and Information Science Education (DEET, 1992).These goals were briefly summarised as follows:

- greater emphasis on flexible and multidisciplinary course structures as opposed to the narrow technical approach suggested by ANTA;
- courses emphasising a design, engineering and systems applications (e.g. use of CASE tools to promote design skills);
- greater employer involvement in the course planning and delivery; and
- more industry based learning (e.g. industrial experience and project for students).

The Bachelor of Applied Science in Information Technology (University of Technology, Sydney) is another example. Here, the NBEET (1994, p. 239) quoted that the Head of School of Computing introduced a lifelong learning programme by seeking to achieve the following goals:

> ...support students to develop knowledge, skills and values appropriate to learning and professional practice. Teachers have the freedom and are encouraged to make attempt to have a very open process of keeping up with the literature and get students involved in critical analysis and reflection of what they are doing. They provide opportunities for students to take responsibility for their own learning. Students set their own assignments in particular area of study that they are interested. They adopt a holistic approach to the education of students by acknowledging their learning needs. The active involvement of teachers in the learning process contributes to the students' learning process.

The NBEET (1994, p. 1) Report defines lifelong learning as follows:

> ...Lifelong learning is promoted when students are exposed to tertiary teaching environments which encourage active search for meaning, leading to an outcome

of a more complete understanding, while a 'surface' approach involves learning by rote and relies on memorising.

4.2 Module size

In a modular curriculum, the course must be broken down into modules. The determination of modules into a fixed number of teaching and contact hours needs to be worked out exactly by applying a structured instructional analysis. Otherwise, some modules may be overloaded or some others may have too few or trivial activities to perform. An extensive examination of several local and international curriculum handbooks seems to suggest that none of the institutions has implemented a modular approach to their IT courses.

IT knowledge is eclectic because it is built on the integration of several disciplines such as Accounting, Computer Science, Economics, Mathematics, System Theory, Psychology and Organisational Behaviour. In addition, due to fast technological changes, the IT curriculum needs to be restructured on a regular basis as some modules may become dated and new ones need to be introduced. Furthermore, the introduction of new modules may cause integration problems or even conflicts with the other streams of modules.

4.3 Trends in Computer Assisted Systems Engineering (CASE) tools

CASE tools are important productivity tools for the IT professionals. These tools help the analyst/programmer to develop faster and better business information systems. Binder and Philips (1991) showed that the proportion of CASE tools used by industry is on the increase since 1988. But, they stated that many users seem to be dissatisfied with the use of CASE tools due to their lack of flexibility, complexity and proper individual training.

Industry is continually developing more complex information systems. To meet the industrial demand, design tools need to be introduced into the curriculum. The introduction of software design tools into the classroom is time consuming. However, there are now on the market new design tools on Personal Computers which are based on new methodologies and are user friendly. For example, the use of semantic object modelling (Object Oriented Analysis and Programming) has reduced the learning curve and allowed learners to be more effective and efficient in developing information systems, therefore these new design methods (e.g. Object Oriented approach versus traditional design) affect the learning process and module sizes one way or the other.

Recently, in a controlled study at the University of North Texas, Pelley (1993) compared entity relationship modelling as a traditional approach, using the IEF CASE tool, with semantic object modelling, using the SALSA (1995) CASE tool as a new approach. He found that the students using semantic object modelling were able to create better models, faster, and with greater satisfaction than students using entity relationship modelling. A second study performed at Auburn University (Marshall, 1993) found that students who had no prior database knowledge or experience could after three hours of instruction, successfully apply semantic object modelling using SALSA CASE tool. In fact, these students were able to out-perform, as measured in terms of quality, speed and satisfaction, graduates of a 45 hour database class who were using more traditional technologies.

4.4 Class sizes and students' preferences

Boyton and Zmud (1987) stressed that the ideal number of participants in a computer session according to a survey of trainees was two to ten and the ideal length of a training session was about two days. The authors also stated that the trend towards offering training on computer software will continue as new software packages are developed and must be learned. Chaney and Wills (1993, p. 22) stressed that to enhance trainers effectiveness, it is important to consider trainee preferences when designing and scheduling software training sessions and the major problem in such sessions from a trainer's perspective was the number of students in training sessions.

4.5 Impact of computers on teaching and the learning process in the classroom

Students approve the use of computer software in the classroom and there is an indication of a significant decrease in the time required to complete a course when compared with the traditional methods of teaching (Telfer & Probert, 1987). Wise (1987) showed that a micro-based instructional approach to Science Education is more effective than the traditional approach of teaching. Sherwood et al (1987) showed that the use of technology enhances comprehension and learning, but their research methodology was somewhat biased as the sample was small and not taken randomly. Hattie (1988) stressed that teachers ought to vary their form of instructions and that if educators become more innovative in using the computer in the classroom, students will benefit and achieve better results. DEET (1993a, p. 9) cited a University of Queensland survey of 206 students, selected randomly in the Bachelor degree courses and reported that students' positive attitudes towards computer based learning increased during the course.

Table 2.2
Attitudes towards computers (Source: DEET, 1993a, p. 9)

Results of the survey	Before (%)	After (%)
Positive attitudes	41	74
Negative attitudes	33	21
Not sure	6	5

Scardamalia and Bereiter (1993) argued for computer-based knowledge-building environments in education to promote progressive discourse. Therefore, the use of CASE tools, for example, is helpful as a knowledge builder and accelerate the learning process (Marshall, 1993: SALSA, 1995).

5. Vocational Curriculum Models

This section considers the content and CBT driven models as two vocational curriculum. The former emphasises the development of general vocational knowledge and the mastering of the content of the syllabi. Kangan (1974) recommended the development of the individual learner rather than directly matching employment requirements. Recently, Finn (1991) also reaffirmed the importance of a general and vocational education approach by stressing the need for the development of underlying broad knowledge, interpersonal and problem-solving skills. However, under pressure from employers to provide a responsive vocational education system, the Federal and State governments have implemented a uniform and standard CBT course across Australia. The CBT model promotes a curriculum based on pre-specified and observable learning outcomes which emphasise job related activities. Proponents of CBT claim that this model is more responsive to industrial requirements and technological changes than the first model.

5.1 General versus vocational education

One needs to define the terms "general" and "vocational". In this study, the term general and non-vocational means subjects which belong to the arts and sciences. These subjects have been designed principally to enhance knowledge irrespective of the specific uses to which it might later be put (e.g. Mathematics). On the other hand, vocational and non-general subjects are designed to enhance employability (e.g. Programming). Without wanting to start a debate, there are subjects which impart both knowledge and skills to enhance employability. For example, a programming course does not need to be purely vocational but may include general topics such as the application of hashing theories to disks accesses.

The next section describes in more detail the two contrasting curriculum models.

5.2 Content driven model

5.2.1 Definition

The content driven curriculum is one of the approaches to vocational curriculum development. It is obviously subject centered as illustrated in Chapter Three of this study, but it is also problem centered because learners need to focus their attention on, and attend to, problems related to the real world.

5.2.2 Overview of the Associate Diploma in Applied Science (Computing) course

An overview of the course based on the content driven model is provided in Appendix A (Associate Diploma in Applied Science course # 9600). This model has evolved, over twenty years, around the teaching of an established body of knowledge related to IT. This is widely used and based on the acquisition of knowledge. The subjects are built around a core body of knowledge as suggested by Goldsworthy (1993, p. 122). The content is sequentially structured and teachers provide learners with opportunities to resolve problems of medium complexity that they are likely to encounter in their work as information technologists. Database Design 102 syllabus (1993) where the section on relational algebra was removed, is also provided in Appendix A. Chapter Three of the study examines in detail the historical account of changes that have occurred in the curriculum since 1970 and their consequences.

5.2.3 Advantages of the content driven model

A content driven curriculum has some advantages for curriculum planners, students, teachers and educational managers. Firstly, Soucek (1993) reported that students made easy connections between various skills because there was more flexibility in knowledge and skills integration than in a modular approach. Secondly, Teachers have more time and freedom to make decisions on planning their lessons according to the complexity of the subject and students' needs. Curriculum planners can cluster skills into a useful structure within a semester based subject. Finally, subjects are easily clustered into an overall discipline and skill structure through the use of structural analysis. For example, the semester course consists of five subjects. Each subject is allocated 4 hours per week of face-to-face teaching over a period of 15 weeks with an additional three weeks for testing, examination and staff development. Fulltime students normally attempt 5 units per semester with a full load of 20 hours teaching per week with the exceptions of final years students completing projects or industrial experience. The final project is equivalent to a 60 hours unit and students are normally obliged to complete it in the last semester under the supervision of a teacher. Another advantage of this approach is that it is cost effective for educational managers who are able to maintain easily control over a teacher's performance in monitoring students' pass rates in a centralised examination system. A high rate of failures among certain subjects, puts the individual teacher on the spot.

5.2.4 Disadvantages of the content driven model

One of the major problems of this model is related to the amount of resources needed to update the syllabi and their content. Due to technological innovations and changes, the curriculum, including the educational goal and syllabi, needs to be updated on a yearly basis. Furthermore, as the computing personnel who perform a variety of work need different knowledge and skills, the amount of curriculum changes is often underestimated. It is sometimes difficult to predict the activities of future job holders, however, useful reports exist providing detailed trends in software and hardware, and visions of the IT activities (DEET, 1990: Strategic Research, 1995). These problems are discussed further in Chapter 3 of this study which provides an historical account of changes that have occurred in the syllabi and content driven curriculum models.

5.3 Competency Based Training (CBT) driven curriculum model

5.3.1 Definition

The fundamental problem is the notion of what "competency" means. In the technical manual on assessment (Hager et al, 1994, p. 5), "competency" is defined as the ability to transfer and apply skills to new situations and environments to a standard of performance required in employment. A uniform and standard course across Australia is favoured. Rumsey (1994, p. 3) stated that CBT was an educational and training approach focusing on work related outcomes. He also claimed that this approach enables learners to develop broad-based skills and knowledge as a basis for lifelong learning. This is in contradiction with the NBEET (1994) Report (p.239).

Thus, the concept of competency focuses on demonstrable and observable learning outcomes defined in terms of behavioural objectives and on what is expected of an employee in the workplace rather than the learning process. In fact, the advocates of CBT promote the idea of an education and training approach based on work-related activities and learning outcomes, based on pre-specified and observable skills. Furthermore, they seem to ignore that there exists a division between vocational and general education and want to collapse education and training into one paradigm of flexible skills formation through Competency Based Training. There is evidence that a CBT approach over-emphasises short-term workplace skills at the expense of long term lifelong skills.

According to Soucek (1993), there was a period in the 1960s and 1970s, in Australia, when Life world skills were given a receptive ear by policy makers. By contrast, the present CBT educational policy direction appears to be about how much time and effort should be given to education and training for skills formation at the expense of pedagogical pursuits of students' self-actualisation and intellectual autonomy.

The Finn (1991, p. 3) report defined several key competencies which all post-compulsory education and training programs should include: language and communications; mathematical knowledge; scientific and technological understanding; problem solving; and personal and interpersonal. However, Finn does not suggest how these competencies can be achieved.

In a survey of 236 people working for government and private organisations, DEET (1993b, pp. 37-40) reported the importance of some skills needed for workers in professional occupations (e.g. business people, teachers and public servants).

Table 2.3
Most competency skills in demand (Source: DEET, 1993b, pp. 37-40)

Competency skills in demand	%
Communications	97
Problem-solving	95
Use of IT	90

Table 2.3 shows that employees with communications and problem-solving skills, and able to use Information Technology, are the mostly valuable for employers.

At a later stage, other competencies were added to the Finn report. They were considered essential for young people entering the work force and were as follows:

- collecting, analysing and organising information;
- communicating ideas and information;
- planning and organising activities;
- working with others in teams;
- using mathematical ideas and techniques;
- solving problems; and
- using technology.

From the above, competencies appear to be related to generic capabilities or abilities. However, one of the difficulties with emphasising general abilities or generic competencies is that they may be more dependent on the relative contributions of individual differences of a person rather than on the direct impact of instruction.

5.3.2 Competency versus performance

Preston and Walker (1993) stated that competence is complex. It involves the combination of attributes, knowledge, capabilities, skills and attitudes, structured into competencies which enable an individual or group to perform a role or set of tasks to an appropriate level or grade of quality or achievement at an appropriate standard. They distinguish between competence and performance.

Pearson (reported in Preston and Walker 1993, p. 118) acknowledged that performance cannot be done routinely without reflection. Skills require knowledge to make judgement which is required in many situations where there is no one right answer and it is a fundamental aspect of professional practice.

Norris (reported in Soucek 1993, p. 169) argued that competence is a cognitive structure embedded in an activity and is about capacity or ability. He also made a distinction between competence and performance. Performance is actually carrying out the task. A successful approach to training, needs to take into account an integrated deep structure. It needs to be about knowledge and understanding, not just demonstrable performance. Therefore, there is a flaw in the logic of CBT based curriculum. He stressed that the flaw resides in the assumption that if the student produces an appropriate performance in a given situation, that the students have automatically gained deeper knowledge and understanding.

As CBT is based on work-related activities and learning outcomes which are observable, it takes definitively a systematic behavioural approach to curriculum. Learning outcomes are expressed in terms of behavioural objectives. Murray (1987, p. 71) stated that when learning is viewed as a process of reacting to stimuli and is considered predictable, learning performance can be improved. Here, the assumption is that learning can be made more effective by increasing the efficiency of the stimulus. The results of this approach of thinking lead the sector to use more efficient systems of learning such as Computer Managed Learning (CML) and Computer Assisted Learning (CAL) systems. Finally, according to the Senate Employment, Education and Training References Committee report (1995, pp. 50- 60), there is confusion about the definition of competencies and the CBT approach to education and training. In addition, the inquiry report stated that ANTA is more concerned to provide to employers what they want in the short term, a goal which is often in conflict with life long learning capacities (p. 132).

5.3.3 Transfer of skills across domains

The issue of transfer in education and training is of considerable significance. Hager et al (1994, p. 5) stated that "competency" is the ability to transfer and apply skills to new situations and environments to a standard of performance required in employment.

The literature on Cognitive Science discussed earlier in this chapter demonstrates clearly that there are domain specific skills which are not easily transferred across domains. Such skills are used by experts to provide efficient problem solution. The message from the literature on transfer of training is that the concept of general strategies or competencies has been oversold. There are no substitutes for the building up of knowledge basis in specific domains. It suggests that ways of thinking applicable for one domain of knowledge may be inapplicable in another (Snow & Swanson, 1992).

5.3.4 Overview of the Certificate IV and Diploma of Information Technology courses

An overview of the Certificate IV and Diploma course, based on the National IT Curriculum, is provided in Appendix B. This first year course is classified at the Australian

Standards Framework Descriptors as level 4 (ASF 4). The second year of the Diploma course is recognised as a level 5 (ASF 5). At these levels, workers are expected to gain substantial in-depth knowledge in some areas in order to work independently and supervise others. The nominal durations of the Certificate IV and of the Diploma are 720 and 700 hours respectively. It must be noted that the two courses offer a wide range of core modules with a minimum number of prerequisites. There is also a wide range of electives and the Certificate IV/Diploma courses are divided into three streams: technical and user support, and personal computer software development. The nominal duration of each module is 20 hours, except for the Accounting for Non-Accountants and system project units which are allocated 60 and 100 hours respectively. It must be noted that students may apply for exemption for the full, or part, course through the process of Recognition of Prior Learning (RPL). There are several cases where students successfully have obtained the Certificate IV or the Diploma award at the end of this RPL process. The profile of the Certificate IV course is studied in more detail in Chapters 3, 5 and 6, where the two contrasting models are again compared.

5.3.5 Advantages of CBT

Many favourable comments have been made about the potential for more flexible course delivery through modular programmes from an educational management aspect. These include: increased access; assessment of prior learning; increased choice; more innovative academic content for new modules; better provision for part-time modes of study; greater opportunity for transfer between further and higher education sectors; more opportunity to transfer between modes of study; and greater flexibility for mature, disabled and under-represented minority groups to build their own learning programmes.

Atkins et al (1993) reviewed some of the beneficial aspects of modularisation linked with credit accumulation and transfer, but offered these pertinent reminders about quality and assessment:

> ...a fear expressed by many we spoke to that uncontrolled modularisation will weaken the quality of learning achieved in higher education. For example, although some subjects can be studied on a cafeteria' basis, others require a linear progression through a hierarchy of concepts of increasing cognitive complexity and difficulty. The growth of general cognitive skills and personal competencies may also be better served through a developmental rather than an accumulative framework. Further, in modular schemes, summative assessments are likely to occur more frequently while the opportunities to remedial learning deficiencies may become less.

Brown and Saunders (1995) stated that modularisation originated from significant theoretical and management policy suggesting educational advantages of providing flexible learning path and increasing access to a greater variety of students. Robertson (reported in Brown and Saunders, 1995) investigated the question of credit accumulation and transfer within and between higher institutions in the U.K. and noted that about 80% of institutions were committed to developing a modular system in conjunction with a semesterised academic year.

5.3.6 Disadvantages of CBT

Modularisation and Module size

One of the fundamental principles of the CBT curriculum is the modularisation of topics with a minimum number of prerequisites (NSW TAFE,1992/3). The issues of modularisation were discussed previously (p. 23). An overview of the first semester course is attached in Appendix B. All the CBT modules of the National IT curriculum are fixed at 20 hours or multiples thereof such as the Accounting for Non-Accountants subject which covers 60 hours to complete. There were 21 modules offered during the first semester 1995. The total face-to-face teaching hours was estimated at 360 hours, spread over a period of 19 weeks, instead of the 15 weeks used under the content driven model. Under the modular approach of CBT, there is a move away from the centralised examinations system, to implement regular assessments of each learning outcomes as the course progresses.

The majority of the theoretical and practical modules such as program design, computer programming and database design must each fit into a 20 hours module which is a problem because of the amount and complexity of these subjects. Kroenke (1995, p. XI), who teaches fundamental concepts in database design, stated that he needs at least 45 contact hours (4 hours per week for 11 weeks or a semester) to cover the subject. Furthermore, the anecdotal evidence among teachers confirms that the modularisation system of IT courses fosters a "surface" approach because of overloading problems. Some other topics such as information gathering in systems analysis have too few or trivial activities to perform. For example, activities related to a project based on a life cycle methodology, is fitted into a sixty hours module.

Fragmentation of topics and learning activities

Soucek (1993, p. 170) argued that fragmentation was another problem. He said that:

> ... Modularisation had the tendency to fragment and isolate clusters of skills, without providing useful structures for the students to make connections between these discreet skills. The continuity of development of ideas might completely break down. Consequently, even after a prolonged period of study, students might fail to understand deeply into any area. They might acquire a number of skills, but these might allow them merely to skip over the surface of what informs those skills. This is an obvious risk of any modular curriculum as suggested in this study.

However, Brown and Saunders (1995, p. 101) made the following remarks about the problems of modularisation:

> ...There are concerns from teachers about students not making crucial theoretical and methodological links between modules. Consequently, opportunities for critical comparison and evaluation are lost. This may be especially the case for combined or independent studies students where teachers may not have planned or anticipated the choice of certain kinds of pathway or module permutations. However, it is likely that teachers may have underestimated the ability of students to synthesise diverse material into meaningful pattern, and in any case, perhaps

overestimated the integration of old style courses (referring to semester units) in the past. There were, of course, some obvious advantages in having small modules of skill or units of knowledge. They might provide more flexibility to students, who are able to exercise more individual choice in how they mix the different components of a course Therefore, it is necessary to provide students with synoptic assessment appropriate at certain stages. Also, prerequisites should be evidenced in programme documentation and student handbooks. Annual monitoring of courses and routes should be undertaken to encourage an adaptable curriculum which looks for integration, and aims to avoid replication of content between modules where appropriate.

Furthermore, there are criticisms of modularised curriculum coming from the teachers themselves. Their reaction to modularisation of curriculum in Western Australia is well documented (Soucek 1993, p. 170). Some of their major criticisms were directed at the lack of continuity of curricula in all core subjects. The general perception of the teachers was that students kept on skipping over the surface of what normally underpins general knowledge and understanding. Furthermore, the 10 week modules (against 20 hours per module allocated by the National IT Curriculum) made it impossible for teachers' to fulfil their role as a teacher in that they did not even know their students' names.

According to Brown and Saunders (1995, p. 101), modularisation encouraged staff to divide the curriculum into smaller and separate parts, with each member of staff having responsibility for a set number of teaching blocks. They stated further:

> ...Yet at the same time, modularisation requires staff to be more aware of overall systems and structures which affect schemes, departments and the university as a whole. It is difficult to know how each individual action affects everyone else. Furthermore, prerequisites for later modules need to be clearly outlined well in advance, so that the consequences of choices are realised at an early stage

Curriculum planners need to be aware that IT courses developed on a modular basis fragment computing cognitive activities into narrow job related activities such as Programming modules (A403-A416), Documentation techniques (A408), System Documentation Methods (B406) and System Development Models (B407) modules (Appendix B). According to Whitten et al. (1989, p. 129), this approach is against fundamental principles of any systems methodology which stresses the integration of the development phases for successful computer systems development. In other words, project leaders, systems analysts, programmers and IT users need a disciplined and integrated approach to the development, implementation and maintenance phases of computer systems. Although such an integrated approach does not guarantee success, it improves the chances of success in systems analysis and design, programming activities and implementation. The other basic system and programming principles are that structured design and techniques, coding and documentation need to be integrated by an appropriate process-centered methodology. Whitten et al. (1989, p. 85) stated further:

> ...Information systems and technology belong to end-users who benefit from them. The IT professionals frequently refer to " my system". This attitude has in part created an "us versus them" environment. Although, IT professionals work hard to create technologically impressive solutions, those solutions often backfire because they don't address the real business problems or they introduce new technical

problems. For this reason, end-user involvement in any system development and implementation, is an absolute necessity for successful systems development and, therefore, documentation must be a working by-product of the entire systems development effort. For example, comments should be placed in the computer programs, not after the program is built.

Creativity

In their submission to the Senate Employment, Education and Training References Committee investigating ANTA (1995, p. 66), the Australian Association of TAFE Managers (AUSTAFE) stated:

> ...The introduction of CBT may not be appropriate to all learning disciplines, i.e. Management Studies compared with engineering or industries which are regulated contrasted with individual learning in the affective domain, e.g. Arts...

In the same inquiry (1995, p. 21), the Australian Council for Private Education and Training (ACPET), wrote:

> ...There is little divergence or innovation possible in delivering vocational skills for emerging industry practice. The ultimate outcome, if this rigid conformance continues, will be a stifling of creativity in training delivery and content which has the potential to lock Australia into non-competitive global practice, the opposite of what Government reforms aim to deliver.

Narrow development of CBT curriculum

According to the Senate Employment, Education and Training References Committee report (1995, p. 131), curriculum development should have involved providers of courses, including the teachers. Several submissions criticised the CBT curriculum process because stakeholders were not identified clearly and represented. Specifically, the students, particularly the future students of the vocational education and training sector, were not identified as major stakeholders. Also parents of future students were not represented in the bodies which control the sector. Anderson and Jones (1986, pp. 20-40) suggested using a Search Conference technique for curriculum design to identify educational issues, establishing educational policies and priorities and developing plans for solving educational problems. Instead the National Curriculum was based on the DACUM methodology which focuses solely on occupational activities and excludes other major stakeholders (e.g. teachers and graduates). The disadvantage of the DACUM system is that the conflicts between short-term goals of what employers want and long-term goals of creating a vocational system, which is concerned with broad generic skill development and life long learning capacities, are not resolved.

CBT learning outcomes cannot be identified in unforeseen situations

The proponents of CBT claim that knowledge is evidenced in a performed skill. They asserted that knowledge is constituted in what people need to know in order to perform or demonstrate a certain skill. However, the question arises: does a learned performance constitute a competent performance if it is not underpinned, at the same time, by knowledge or a theoretical understanding of the activity which needs to be performed. Norris (cited by Soucek 1993, pp. 171-172) argued that in professional practice, CBT approach is flawed for three reasons. Competency cannot be defined in advance because it is always situational specific. As a consequence, a learned performance might not guarantee competent performance in altered circumstances. Therefore, the CBT approach cannot anticipate all possible and different occupational situations. Focusing on performance rather than on knowledge is unlikely to equip the future information technologists with the capacity to deal effectively with unforeseen circumstances and problems

Standard of assessments

In the National Curriculum, fulltime students are assessed at least twice per module. There may be as many as 40 modules taken by students during an academic year. They may be, therefore, assessed between 40 to 80 times in any one year. The demands on CBT students are especially acute when deadlines for assignments coincide with one another. Perhaps the overall amount of assessment throughout the modules needs to be reduced.

Summative assessment by way of examinations at the end of each semester is not appropriate for many modules. Assessment is best staged at intervals through the programme of learning to enable formative feedback which informs students learning. Also, because the assessment of competent performance is dependent on the assessor's subjectivity (e.g. the teacher), it assumes that the personal values and knowledge of the assessor and the tested person are identical or at least similar. What is needed are standards of principles of professional judgement that can inform competent action in the context of uncertainty and change said Norris (reported by Soucek 1993, p. 168). Assessment must be based on evidence of prior achievements. A portfolio of performances must be compiled to show that the person is able to perform IT functions in the workplace together with the skills, knowledge and understanding which underpin such performance. This approach is in operation in the UK to train managers. The proponents of the CBT approach to assessment of competence suggest an alternative route to accreditation which may be more closely related to real workplace performance than the traditional tertiary courses with their emphasis on time serving, teaching and reading. This approach means that the system may provide an alternative route to obtain a recognised Diploma qualification through workplace competence on the evidence from past achievements rather than on the basis of academic teaching.

However, at the end of 1995, the Skills Standards and Accreditation Board (SSAB) agreed to register the Certificate IV and Diploma in Information Technology in Western Australia, under the conditions of introducing a grading and standardised assessment system for CBT core modules. All students needed to undertake these assessment tasks. This was an important decision because CBT assessment processes do not have the confidence of industry and of those issuing qualifications, the integrity of the system for recognised training will be lost (Senate Employment, Education and Training References Committee, 1995, p. 48; Watson, 1994).

6. Summary

Research findings from the workplace, identified not only important technical skills but, also interpersonal, communications and problem-solving skills which need to be fostered in the curriculum. The curriculum should contain not only technical subjects like, systems analysis and design, database and data structures and programming, but also general vocational subjects. Basic disciplines such as Mathematics, Accounting and Psychology need to be part of any information science curriculum. A multidisciplinary approach seems to be ideal, because IT skills are based on a wide range of disciplines. A greater emphasis on flexible and multidisciplinary course structures as opposed to the narrow technical approach, is suggested by the literature on Information Science Education. Emphasis on designing systems and programming activities, greater employer involvement in the course planning and delivery, more industrial experience and projects for students, are other recommendations

The review of the literature has shown that project leaders and analyst/programmers are problem-solvers. They require not only organised knowledge but also need different strategies in order to solve problems successfully. The literature demonstrates clearly that problem-solving skills are domain specific skills which are not easily transferred across domains. In this case, learners focus their attention on building organised cognitive structures and processes. Therefore, the content approach to curriculum seems to be more appropriate than the CBT approach which focuses only on job related learning outcomes. The content based model has several other advantages over the CBT approach. Curriculum planners can easily cluster and integrate skills from multiple disciplines into a useful structure within a semester subject constraint. Students are able to easily make connections between various skills because the model is flexible and non prescriptive. As learning information science concepts is complex, teachers are able to spend more or less time knowing whether students have gaps in their knowledge basis. The use of modern software design tools and techniques across the many subjects and disciplines may help teachers to discover gaps in students' information basis and facilitate meaningful learning. CASE tools and computer programming need to be adequately integrated into the subjects/disciplines to promote algorithm design and skill transfer. For example, activities based on a framework such as a skeleton program with missing lines in which the students exercise their thinking processes is an effective and efficient method of teaching. In addition, students are motivated by using computers. Finally, they prefer to learn software in the classroom in a small group and faster learning can occur.

Research tends to favour the content over the CBT approach to curriculum design and development. The CBT model is based on generic skills which cannot be defined in advance because they are always situational specific. The review of the literature stresses that competent performance cannot anticipate all possible and different occupational situations. Focusing on performance rather than on knowledge is unlikely to equip the future IT problem-solvers with the capacity to deal effectively with unforeseen, circumstances and problems. CBT model seems not to foster transfer of skills. Transfer cannot be applied to new situations because the CBT model over-emphasises workplace skills at the expense of the general knowledge (e.g. Mathematics etc.) and narrow technical skills (e.g. features of the programming language). There is evidence that the introduction of CBT is not appropriate to some learning disciplines such as management studies. Furthermore, assessment throughout modules needs to be reduced. Assessment of competent performance is dependent on the assessor's subjectivity because there is no standards of principles of professional judgement that can inform competent action in the context of uncertainty and change. Therefore, the industry and the providers issuing qualifications may lose confidence in the integrity of the CBT system.

The literature suggests that ANTA as the authority body on The National Curriculum, did not represent all the stakeholders such as public and private providers, teachers and students in the development and implementation of CBT courses. But, there are many favourable comments made by educational managers about the potential for more flexible course delivery through modular programmes. For example, these include: opportunities for recognition of prior learning; wide choice of modules; introduction of innovative and new modules; greater transfer between further and higher educational sectors (UK); and greater flexibility for mature students and under represented minority groups to build their own learning programmes.

The next chapter examines in-depth the historical account of changes which have occurred under the content driven curriculum model and their implications for learners, graduates and employers.

CHAPTER 3

HISTORICAL ACCOUNT OF CURRICULUM CHANGES THAT HAVE OCCURRED SINCE 1970 AND THEIR IMPLICATIONS

1. Introduction

This chapter describes the major influences and changes that have occurred in the IT curriculum since the 1970's and is related to the historical reconstruction of the Information Technology (IT) department of the Western Australian Technical and Further Education (WA TAFE) College of Perth. The degree to which the content driven curriculum model has responded to the needs of the individual learner by seeking to be relevant to rapidly changing technological workplace is examined. Also examined is the degree to which increasing technological changes have been introduced in the classroom in delivering instructions and the appropriateness of a modern pedagogical approach such as Computer Assisted Instruction (CAI).

2. Objectives

The objectives of this chapter of the study are to:

examine the historical changes and influences that have occurred in the WA TAFE computing education curriculum since its inception in 1972, specifically the changes made in the curriculum and the syllabi in terms of educational goals, content mix and profile, and assessments types;

investigate the relevance of the curriculum and the syllabi to meet the changing needs of technology and the Information Technology industry;

examine the importance played by the core subjects, the theory versus practical work and the general versus the technical subjects to meet the occupational requirements;

investigate the impact of the Federal and State governments and professional organisations on the curriculum directions and courses;

examine the pedagogical changes that have occurred in the sector and how they have affected the curriculum and courses; and

assess the desirable and undesirable consequences of the curriculum model adopted by the sector.

3. Historical account of changes that have occurred in the Information Technology (IT) curriculum since 1970 and their consequences

3.1 Brief overview of the types of courses offered since 1970

Table 3.1 illustrates the major changes that have occurred since 1970 when the first computing course was offered at Perth Technical College (renamed recently Central Metropolitan College or CMC of TAFE).

Table 3.1
Brief overview (Sources: Perth Technical College documents, handbooks and syllabi)

Date	Milestone (Fulltime students)	Characteristics	Entry level
1970	1st year of the Certificate in Computer Programming	-Synopsis of courses -Courses ran over one year	Year 10
1971	2nd year of the Certificate	As above	1st year Certificate or equivalent.
1972	Diploma in Computer Programming (1 year)	As above	2ndyearCertificate
1976	Introduction of the first syllabus	Detailed description of facts	
1979	Certificate in Applied Science (Computing)		Year 10
1987	Associate Diploma in Applied Science (Computing.).	Semesterisation of all subjects	Certificate or year 12
1989	Introduction of Teaching Guide.	Activities defined in behavioural objectives terms	As above plus Mathematics & English
1992	Planning of Associate Diploma of Business (IT) from the Outer Easter College of Victoria, but not completely implemented	Modularity and flexible learning	Certificate or year 12
1993	Planning of A/Diploma of Business (IT) of the National Curriculum	Competency Based Training (CBT) and modular approach	Certificate or Year 12
1994	Last intake in the A/Diploma in Applied Science (Computing)	Syllabi-driven	
1995	1st year of the Certificate IV of the Diploma of the National IT Curriculum	CBT and modular approach	Year 12 or Certificate

The initial course was designed to allow fulltime students to enter after three years of secondary school studies and to complete the Certificate in Computer Programming as an alternative to completing years 11 and 12 of secondary schooling.

Later the Perth Technical College started to offer UG3 (under-graduate level 3) diploma courses in computing to provide more advanced training at the programmer and senior programmer level by broadening the optional areas in Science and Commerce and extending the depth of the programming courses from 1972.

In the 70's to the middle of the 80's, the academic year was divided into three terms and the majority of the subjects was spread out over a period of one year. There was one final examination at the end of each academic year and the possibility for students to sit for a supplementary examination at the beginning of the following year.

In the late 80's, the entry level into the course was raised to year 12 and subjects were semesterised. In 1989, the level of entry was raised further to year 12, or equivalent, with Mathematics and English as additional requirements to meet University and College of Advanced Education entry standards and articulation. In addition, teaching guides were introduced to define learning activities in terms of objective performance or behavioural objectives, but they were abandoned two years later because two sets of curriculum documents including the syllabi needed to be regularly updated.

Since the inception of the course in 1970 until 1994, the curriculum model was syllabi or content driven. But, in 1993, the Federal and the State governments through ANTA agreed to introduce a new curriculum model based on Competency Based Training (CBT) and a modular approach which are examined further in this study.

A sample of the course outline and subject syllabus which covers areas such as aims of the course, synopsis, required prerequisites, textbooks to be used, assessment structure and mark allocations and specific topics to be learned can be examined in Appendix A.

3.2 Changes in Educational goal

IT skills needed by the labour market have changed and have affected the IT profession. These changes, in turn, needed to be reflected in the educational goals of the curriculum. Table 3.2 illustrates the changes that have occurred at professional levels since 1970 when the first computing course was offered at certificate level at Perth Technical College.

Table 3.2
Changes in Educational goal (Source: Perth Technical College documents)

Date	Milestone	Educational goal	Duration
1970	Certificate in Computer Programming	Programmer	2 years F/T
1971	Second year of the Certificate	As above	1 year F/T
`1972	Diploma in Computer Programming	As above	1 year F/T
1979	Certificate in Applied Science (Computing)	As above	1 year F/T
1979	Associate Diploma in Applied Science(Computing)	As above	2 years F/T
1989	Introduction of :-Teaching Guide-	Project leader, Systems analyst & Programmer	Abandoned after one year
1991	Changes in assessment weight: examination from 60 to 70%: internal assessment from 40 to 30%	As above	As above
1992	Planning and implementation of a new Associate Diploma of Bus. (IT) from the Outer Easter College of Victoria	IT training at the user level	2 years F/T
1993	Planning of a new Diploma in IT by the National Curriculum : CBT and modularisation (360 modules)	To cover every aspect of IT	2 years F/T
1994	Last intake in the Associate Diploma in Applied Science (Computing) under the content driven model	As above	2 years F/T
1995	Implementation of the first year of the Certificate IV of the National IT curriculum (CBT)	As above but with three stream options	1 year F/T
1996	Implementation of the second year of the Diploma of the National IT Curriculum (CBT)	As above but with stream of specialisations	1 year F/T

The educational goals of the course offered 24 years ago and the one offered today are quite different. In the 1970's, computing courses were designed to provide training specifically at programming and advanced programming level. The aims of the course were changed to reflect the trends in the job market. The course intended to train not only programmers but also systems analysts and project leaders.

In 1994, the Associate Diploma in Applied Science (Computing) course on the syllabi/content curriculum model ceased to take students. In 1995, the first year of the Certificate IV course based on the CBT curriculum model was introduced. The second year of the CBT course leads to the Diploma in IT award.

3.3 Changes in the course profile

3.3.1 Most important core subjects

This section analyses the changes that occurred in the subject mix over the years in the Associate Diploma of Applied Science (Computing) and the Certificate IV. Comparisons are made between the two contrasting courses where it is appropriate. The number of teaching hours delivered was calculated as 100 % over the two academic years of the Associate Diploma in Applied Science (Computing)and the Diploma of IT.

Table 3.3

Most important core subjects (Source: Perth Technical College courses and syllabi)

Allocated time in percentage	1976	1979	1989	1994	1995
Accounting	17	8	0	0	6
English	5	8	0	0	0
Mathematics 1A/B & Quantitative Analysis	14	8	14	13	0
Computer systems theory (Structured design, hardware & software architecture, operating systems & data structures)	21	11	14	20	23
Programming 3GL	43	47	44	38	13
Systems analysis and design	0	8	7	8	8
Database design & 4GL	0	8	7	8	6
Network communications	0	2	7	7	10
Computer project (or Applied Systems)	0	0	7	6	10
Sundry modules (e.g. technical reporting)	0	0	0	0	24
Total in percentage	100	100	100	100	100

Table 3.3 illustrates the percentages of core subjects taught related to the total number of hours delivered from 1976 to 1995.

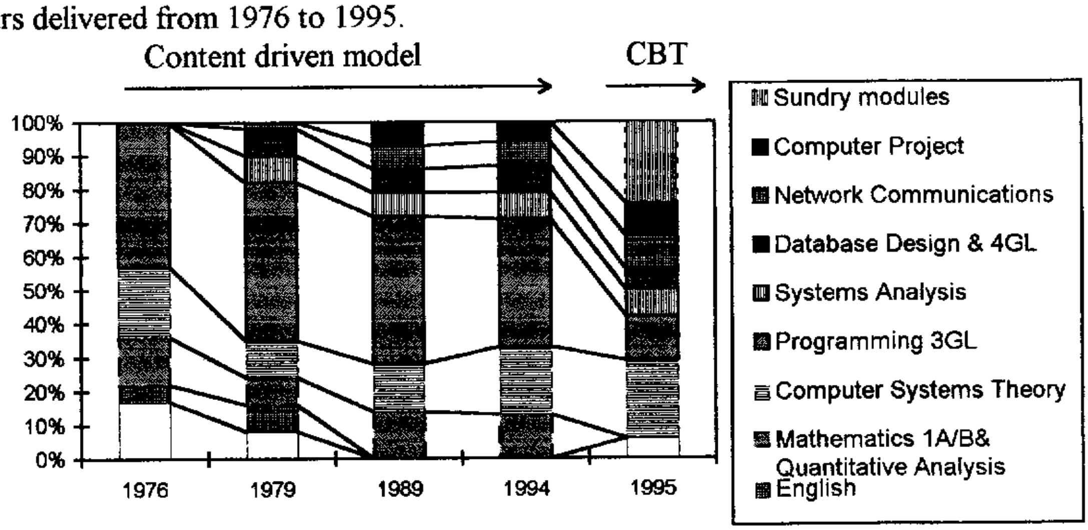


Figure 3.1. Most important core subjects.

Figure 3.1 graphically illustrates the subject profiles from 1976 to 1995. In the 1970's, computing courses were designed to provide training specifically at programming level with emphasis on basic disciplines such as Mathematics, Operations Research, Accounting and English subjects. The course outline drew substantially from mathematical and accounting disciplines because it assumed that the former promoted logical reasoning and the last one was required in understanding business management principles and systems. In 1979, the structure and the content of the course started to change. The curriculum was semesterised and renamed the Associate Diploma in Applied Science (Computing). New subjects such as Systems Analysis, Database Design and Telecommunications were introduced in the syllabus. The new course reflected trends in IT and in industrial needs in the area of relational database. The aims of the course were designed to provide a range of skills from different technical areas to train students not only as programmers but also as systems analysts and project leaders. Therefore, the course not only emphasised practical and technical subjects such as database, network communications, graphics, but also integrated the applications of relational algebra needed for efficient 4GL programming and Quantitative Methods necessary for sound business management decisions to provide graduates with opportunities to further their studies. Syllabi were upgraded substantially several times in 1976/7, 1987 and then in 1989 the last substantial changes were made. After the 1989 academic year, only limited resources were allocated to the IT study area to upgrade the curriculum. Between 1989 and 1994, English and Accounting semester subjects were not core requirements and some syllabi lost their general education content. Also, the relational algebra section in the Database Design 102 subject disappeared from the 1993 syllabus (Appendix A). With the introduction of CBT, in 1995, a semester module (60 hours) named "Accounting for Non-accountant" was re-introduced as part of the Certificate IV course, but dropped soon afterwards. It is noteworthy that sundry modules played a significant role to meet the CBT curriculum requirements while computer systems theory and project work only increased marginally in 1995.

By grouping the core subjects into general education, computer systems theory (including systems analysis and network communications), programming 3GL, database and 4GL, and sundry topics, the following trends can be noted:

Table 3.4
Most important groups of core subjects

Most important groups of core subjects in %	1976	1979	1989	1994	1995
General education	36	24	14	13	6
Computer systems theory including systems analysis and network communications	21	21	28	35	41
Programming 3GL (e.g. Pascal, C, C++, Cobol)	43	47	44	38	13
Database design (CASE tools) & 4GL (SQL)	0	8	7	8	6
Computer project (or Applied Systems)	0	0	7	6	10
Sundry modules (e.g. technical report writing)	0	0	0	0	24
Total percentage	100	100	100	100	100

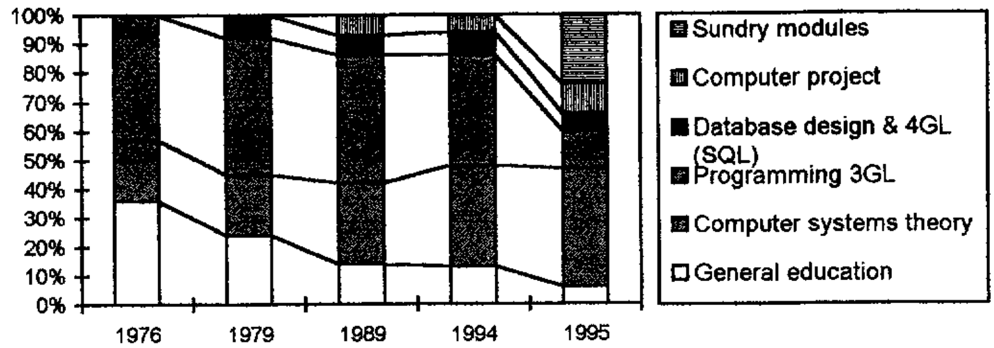


Figure 3.2. Most important groups of core subjects.

Figure 3.2 illustrates how the importance of programming languages in the CBT course under the National IT Curriculum model declined substantially in 1995. Pascal, Cobol, C and C++ programming languages have played a minor role at the expense of sundry modules. These sundry modules are directly related to technical skills focusing solely on the features of commercial database and graphical software packages instead of developing computer programs in 3GL or 4GL. These sundry modules include also topics such as writing and presenting technical reports, developing technical documentation, dealing with personal conflicts in a team and interviewing people. All these activities are directly related to the IT occupation.

3.3.2 Importance of "general" versus "vocational" and "technical" education subjects

A major curriculum issue was the question of balancing general education against narrowly focused training. This question was raised by Kangan (1974) who stated that the sector needed an appropriate balance between a general education and vocationally orientated education. More recently, there were concerns that curricula in colleges became too narrow and focused only on training at the expense of general education and this approach did not show immediate quantifiable benefits in a job situation (Goldsworthy, 1994: Stevenson & Brown, 1994: Soucek, 1993). Here, more research is needed to look at the value of general education in terms of competencies acquired by students for specific jobs.

Table 3.5
Importance of general versus vocational/technical education

Importance of core subjects in percentage	1976	1979	1989	1994	1995
Accounting, English, Mathematics. & Quantitative Methods	36	24	14	13	6
Vocational/technical subjects	64	76	86	87	94
Total	100	100	100	100	100

Table 3.5 shows that, from 1976 there was a noticeable and gradual trend to move away from the traditional disciplines in Accounting, Mathematics and English subjects. These general subjects started to play a minor role in the course in 1989. But, at the same time, the entry level into the Associate Diploma of Applied Science was raised to year 12 or equivalent entry level such as the Certificate in Computer Studies (Table 3.1).

Table 3.5 illustrates the importance played by general education subjects in the curriculum since 1976 when Accounting, Mathematics and English represented 36 % of the total teaching delivery. These subjects declined in importance to 24% in 1979 and 14% in 1989. The percentage of general education subjects such as Mathematics, Accounting and English in the course, remained stable at about 14% between 1989 and 1994. With the introduction of CBT modules in 1995, general education subjects declined to 6 %.

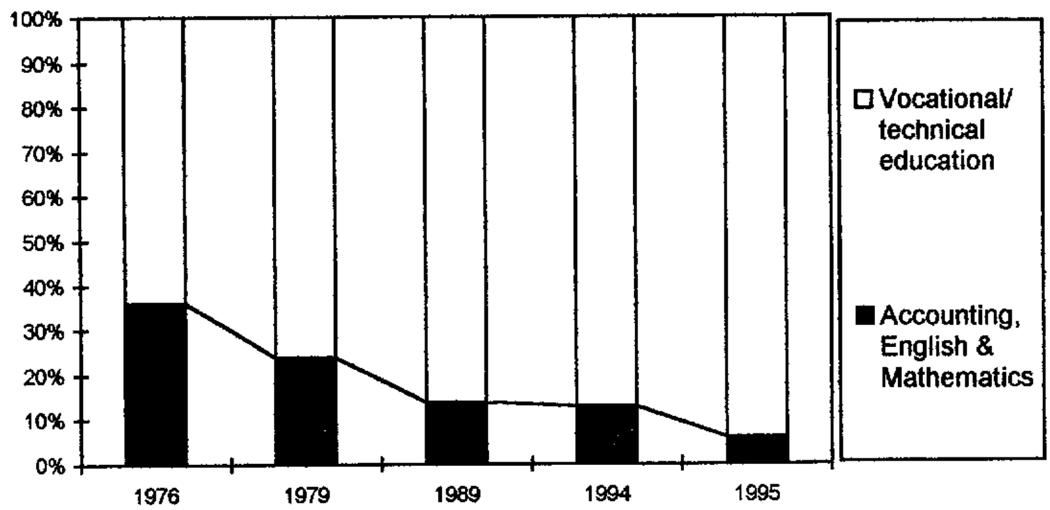


Figure 3.3. Importance of general versus vocational/technical education.

Figure 3.3 illustrates the decline in general education versus vocational and technical education between the 1976 & 1995 academic years:

In 1987, semesterisation of all the subjects was introduced and major upgrades occurred in the curriculum as mentioned previously (Table 3.1). The content of the syllabi was updated and more material was added. After further investigation, it was found that, in 1989, Accounting and English subjects were removed as core subjects, but replaced instead by applied statistical topics such as Quantitative Methods or Analysis. But, at the same time, the entry level into the course was increased gradually to year 12, or equivalent with Mathematics and English as additional requirements to meet University and College of Advanced Education (CAE) entry standards and articulation.

In summary, there has been a decline in general education and a shift towards vocational and computer training with a simultaneous increase in the entry level of the Associate Diploma of Applied Science (Computing) to satisfy articulation requirements with other tertiary institutions. In addition, one should note that during the 1987 academic year, the course was semesterised. This change provided the mechanism to restructure and gave the opportunity to reduce the importance of general education. In 1995, with the introduction of CBT, there was a further decline in general education and a shift towards technical and computer training

3.3.3 Importance of CASE tools and computer programming

The use of CASE tools and computer programming plays an important role in fostering problem-solving skills for the development and implementation of Information Systems. Case tools relate to the use of Oracle design tools which was introduced in1993. Programming activities relate to Third Generation Languages (3GL) and Fourth Generation Languages (4GL). The 3GL includes Basic, Pascal, Cobol, C and PL1 programming. The Central Metropolitan College was the only college to offer PL1 programming when it made use of the IBM AS/400 computer. The 3GL programming played an important part in the curriculum (55% in 1979) as described further in this section of this Chapter. The 4GL programming is related to Structured Query Language (SQL) programming which is used in Database Management Systems (DBMS). In 1989, Oracle was introduced as a 4GL programming language in the database design course.

Each programming subject normally was allocated two sessions of 4 hours per week. It is common practice in the Information Technology (IT) department to allocate at least 50% of each session to practical work on the computer terminals depending on the availability of computer rooms. For students to gain practical experience and integrate their theoretical knowledge, a project unit named Applied Systems was introduced at the beginning of the1989 academic year (See table 3.4).This unit forced students to develop a real case in business information system (e.g. a College Library System) and write the related computer programs to gain practical experience. These activities represented 7% of the total teaching delivery of the course but, in some Colleges, there were also opportunities for students to gain additional practical experience with employers under the supervision of teachers.

Table 3.6
Importance of CASE tools and programming languages

Importance of CASE tools and programming languages in percentage	1976	1979	1989	1994	1995
3GL & 4GL programming languages	43	55	51	44	19
CASE tools	0	0	0	2	0
Other subjects or modules	57	45	49	54	81
Total percentage	100	100	100	100	100

Table 3.6 shows the importance played by the use of CASE tools and programming languages.

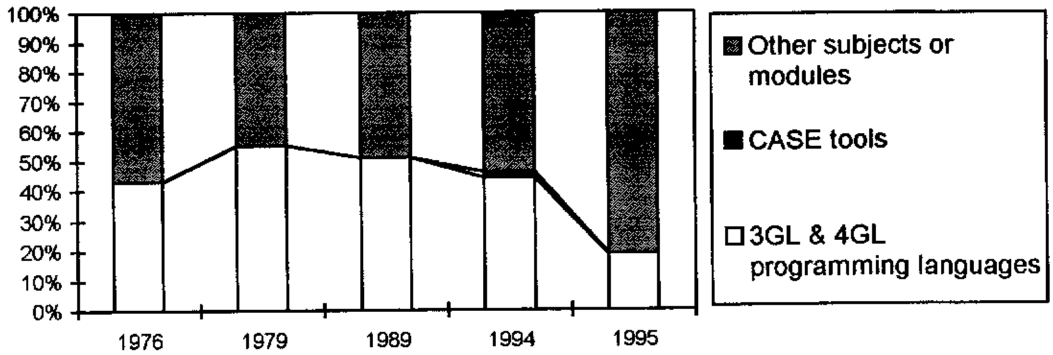


Figure 3.4. Importance of CASE tools and programming languages.

Figure 3.4 illustrates how computer programming increased between 1976 and 1979 and then decreased gradually in importance from 1989 to 1994. These changes were due to the increase in the computer systems theory as shown in Table 3.4. With the introduction of CBT in 1995, computer programming declined substantially in importance to 19%. In 1993, Oracle CASE tools also was introduced as an integral part of the database design subject. However, with the introduction of CBT in 1995, CASE tools became an elective module, divorced from the database subjects (see Appendix B).

3.3.4 Importance of theoretical versus practical computing work

Theory relates to computer systems, hardware and software architecture, systems analysis and network communications. Practical computing work is divided into programming and non-programming activities. Programming activities relate to computer design using CASE tools and programming languages (3GL and 4GL). The non-programming practical activities relate to the use of commercial database, presentation of graphical information through software packages, spreadsheet and word processing. They are not considered programming activities because they focus on the features of the packages rather than the development of computer programs. Non-computing subjects relate to general education and sundry CBT modules introduced in 1995.

Table 3.7
Importance of theoretical versus practical computing work

Most important core subjects in percentage	1976	1979	1989	1994	1995
General education	36	24	14	13	6
Computer systems theory	21	21	28	35	41
Programming work	43	55	58	52	23
Non-programming activities (use of software packages)	0	0	0	0	6
Sundry modules (e.g. technical report writing)	0	0	0	0	24
Total in percentage	100	100	100	100	100

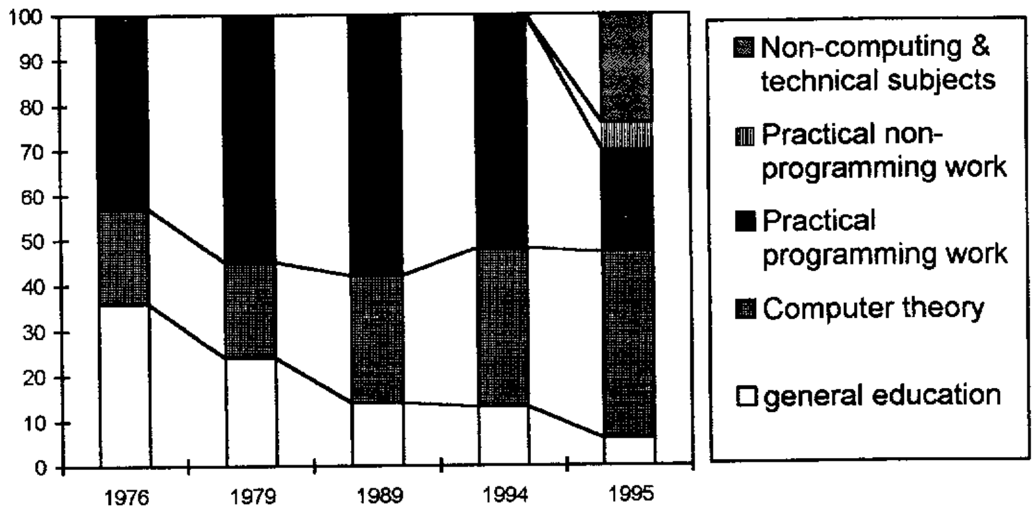


Figure 3.5. Importance of theoretical versus practical computing work.

Table 3.7 and Figure 3.5 illustrate the importance of theoretical versus practical computing work in relation to general education and other sundry subjects. Between 1976 and 1994, the percentage of computer (theoretical and practical) work has increased marginally over total teaching delivery at the expense of general education. With the introduction of CBT in 1995, the non-computing and technical topics related to occupational activities have increased to 24%. They are related to learning activities such as presentation of graphic information, report writings and technical documentation.

Table 3.8
Importance of theoretical versus computer programming work

Theoretical versus computer programming work in percentage	1976	1979	1989	1994	1995
Computer systems theory	33	28	33	40	60
Computer programming work	67	72	67	60	40
Total in percentage	100	100	100	100	100

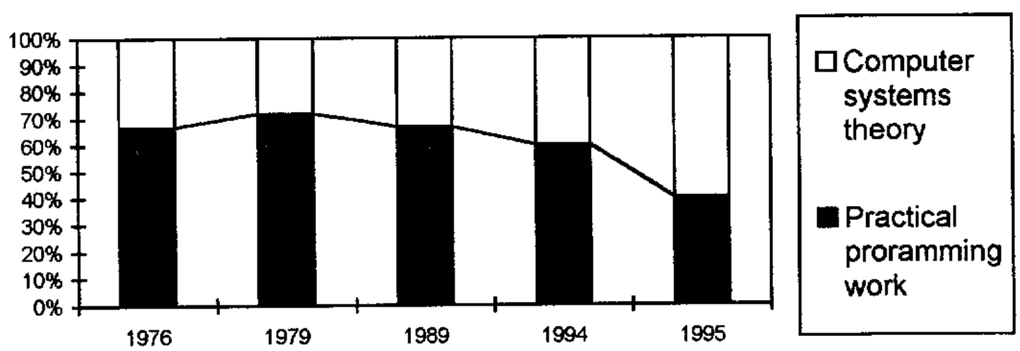


Figure 3.6. Importance of theoretical versus computer programming.

Table 3.8 and Figure 3.6 illustrate the important role played by practical work on the computer terminals versus theoretical topics. Practical work is not only related to computer programming (3GL and 4GL) and development of projects, but also includes the use of CASE tools to develop business information systems.

The percentage of programming versus theoretical work represented about 65% of the computing course delivered and remained more or less the same over the years between 1976 and 1989. In 1994, there were minor curriculum changes made to some of the core syllabi. The number of contact hours on structural design of computer programs increased in the first semester (See computer systems theory in Table 3.3, p. 41). Data structures using C programming became a third semester subject as required two more prerequisites (Programming C101 & C102) in the Associate Diploma of Applied Science (Computing). However, with the introduction of CBT courses in 1995, the practical component of the course decreased further as more time was allocated to teach Local Area Network (LAN) and Wide Area Network (WAN) which are theoretical modules with limited practical work (see Appendix B).

3.4 Industrial relevance of vocational and technical subjects

This section investigates whether the curriculum changes that occurred from 1970 to 1994 were appropriate and relevant to the rapid IT changes which affected the industrial workplace. But, to understand the changes which influenced the computer industry and consequently affected the curriculum, a brief historical outline and trends in the area of I.T. are discussed briefly in the first part of this section. These IT changes occurred in the following field:

- Hardware and communications networks;
- Structured analysis and programming design;
- Programming languages; and
- Database software.

<u>3.4.1 Evolution of hardware and communications networks</u>

In the electronics area over the past 30 years, as the micro-processors and Random Access Memory (RAM) were dropping in cost, the number of components per chip were increasing. More components were packed in a chip at marginally more cost, which in turn made computers more powerful and flexible. These changes promoted more use of computers in society.

Computer hardware is classified into mainframe, mini, or midrange and server, and personal computers. A recent census (Strategic Research, 1995) revealed that mainframe computers are in decline with IBM being the most popular with 4.7 percent of the market share, followed by Fujitsu and Amdahl.

Table 3.9
Market share midrange computers and servers (Source: Strategic Research, 1995)

Market share of midrange computers and servers (above 4%)	1994	1995
IBM AS/400	22.1	23.1
DEC VAX and ALPHA	21.3	22.3
Hewlett Packard range	12.1	14.1
Compaq range	3.4	13.2
IBM RISC 6000	8.4	9.0
Sun	4.3	6.5
Wang	6.3	5.5
Data General range	4.8	5.1
Unisys	4.3	4.0
Prime	4.3	3.6
AT & T Unix	3.2	3..4

Note: Market share percentage was rounded up and consolidated for all the vendors except for IBM.

Table 3.9 illustrates the range of hardware, in the midrange and server computers, used in Australia by organisations. The most widely used processor is IBM's AS/400, used by about 23 per cent of all organisations. It is followed by the DEC VAX (18 per cent) and DEC Alpha (4.2 per cent), and Compaq servers (13.2 per cent). The IBM Unix based RISC obtains 9 percent of the market share. Compaq shows strong growth followed by the IBM RISC 6000 and the Hewlett Packard Unix architecture. Most of the other machines such as the Wang, Prime and Unisys are declining.

In order to be more relevant, the curriculum had to be adjusted continually in order to provide students with immediate employable skills on different range of software and hardware platforms. For example, the Central Metropolitan College (CMC) of Perth operates three midrange computers. Since 1983, it had a DEC VAX running under VMS which was continually updated. In 1988, the terminals were updated by new DEC work stations to be used with Oracle/CASE tools. In 1994, the VAX machines were upgraded to Alpha machines. The Unisys was purchased in 1988 and continually upgraded. An IBM AS/400 was also purchased in 1989 and was continually upgraded and utilised until 1992. There is also a range of stand alone Personal Computers (PC). One cluster of 486's with a server was installed at the beginning of 1995.

In the area of communications, there exist two network types They are the Wide Area Network (WAN) and Local Area Network (LAN). Computer Network facilities such as WAN facilitate sharing of information across geographical locations and appeared around the middle of the 1960's in large organisations. At that time, computer network was expensive. But, with telecommunications and telephone systems facilities becoming cheaper over the years, more and more organisations were using computer networks to manipulate data, voice and image. Common carriers provide data communications channels as either public or private service. The public service works in the same manner as voice transmission by using a dial-up circuit. The private service consists of a leased service which is of higher quality and ensures circuit availability around the clock. A common carrier which receives much current attention is the integrated services digital network (ISDN).

There is also an effort to standardise the interfacing of data communication equipment. Several hardware and software architectures have been devised. IBM introduced the System Network Area (SNA) and was followed by other manufacturers such as Digital's DECnet network architecture. The International Standard Organisation (ISO) has announced their version of the Open System Interconnection (OSI) model of network architecture which has been adopted by the Commonwealth and State governments (GOSIP, 1990).

Networks are used for timesharing, distributed processing, or client/server computing. The latter network configuration enables work to be done both centrally or locally. It may involve WAN and LAN networks such as on the IBM AS/400 (IBM, 1994).

Another form of computer network calls for local installations and appeared only in the late 1970's. The LAN is an in-house network which is owned completely and operated by the organisation.

Table 3.10
Market share of LAN Operating Systems (Source: Strategic Research, 1995)

Market share of LAN Operating Systems (above 5 % only)	1994	1995
Novell Netware	53	56
TCP/IP (Mainly IBM)	8	10
Digital: Dec Pathworks	9	8
Appeltalk	6	5

Table 3.10 illustrates the proportion of organisations using the leading Local Area Network (LAN). By far the most popular LAN is Novell Netware whose market share has increased from 53 percent to 56 percent of all users. No other LAN operating system comes close. Other significant suppliers are TCP/IP which is still growing, and Digital and Appletalk products which are declining. Microsoft LAN products (MS) and IBM, OS/2 which are not listed in the table, are becoming much more important players.

In the 80's, computer networks were introduced by Curtin University in their classrooms as in Figure 3.7.

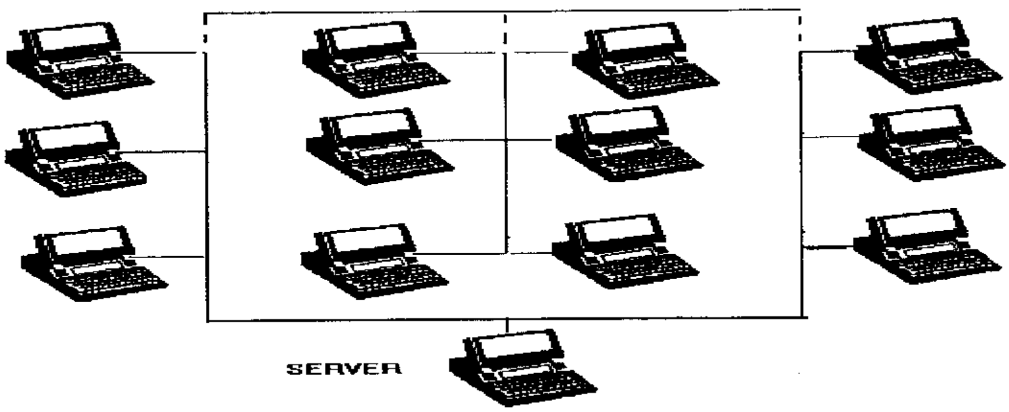


Figure 3.7. Classroom Local Area Network (Source: Curtin university, 1987).

The Central Metropolitan College, Perth campus, installed one cluster of 486's at the beginning of 1994. The network is organised in a ring topology. The server which is a micro-processor with disks files, contains all the applications packages such as the common database software.

3.4.2 Impact of structured design concepts and methodologies on the curriculum

In the 1970's, there were software trends and industrial needs to have graduates equipped with in-depth knowledge and experience in structured methodologies for several reasons which will be discussed further in this section. In 1979, the Diploma course was converted into the Associate Diploma and semesterised. In addition, new subjects such as Systems Analysis and Database were introduced which emphasised on structured design methodologies. Research in structured design started in the1960's. Organisations noticed that some programs were less costly to produce and to maintain than others. They gathered data on many different programs in order to determine what characteristics seemed to be associated with those programs that were least costly to develop and maintain. They observed that programs that were the least costly to maintain, were generally implemented with a modular structure. However, certain kinds of modular structures reduced the maintenance cost more than others. Also, structured design was developed and later applied to programming languages such as Cobol, PL1, Fortran, Assembler, Pascal and C programming, but to a lesser extent to Basic programming which lacked flexibility to accommodate structural methodologies. Therefore, Basic programming was dropped from industry and the syllabus in 1979 as a compulsory subject.

Other changes occurred at the beginning of 1970 in the software industry as hardware became more powerful. More sophisticated systems development methodologies such as the Arthur Andersen, Pride, SDM70 and other design techniques (e.g. Excelerator) appeared on the market. Industry realised that there were many benefits that improve any project in adopting these system methodologies and standards (Whitten et al., 1989, p.

128). This forced system analysts and programmers to produce higher quality and well documented systems to improve communication and eliminate duplication of effort. The rationale of the introduction of the above methodologies was not only to raise the standards of documentation of complex systems but to facilitate changes to the systems and programs, to allow for growth, to simplify and modify programs easily and develop systems and programs which were hardware independent. Therefore, for students to gain practical experience in structural design and programming and integrate the knowledge of several units based around structural design methodologies and techniques, a semesterised project unit was introduced into the curriculum (1989), which represented about 7% of the total teaching delivery of the course (See Table 3.3 & Figure 3.1).

3.4.3 Evolution of Third Generation Programming (3GL) programming languages

It was found that it was practically impossible to teach good programming to students who had a prior exposure only to Basic programming. Therefore, most Colleges started to utilise Cobol, Fortran, PL1, Pascal, C programming or other similar structured computer languages to teach structured design which used a top down approach in 1979. It is believed that Pascal is still the preferred language taught in secondary schools and some universities. Since the middle of 1980's, programming in C has been and is still one of the more recent well established language. The emerging language, C++, which is an extension of C programming, uses Objected Oriented techniques. The new Objected Oriented software approach is more natural and easy to use than the traditional approach according to Kroenke (1995, p.219) and Date (1995, p. 630).

By comparing the College IT syllabi (the same syllabi are used across the sector) over a period of 24 years, the percentage of each programming language taught over the total number of hours delivered in programming was calculated. Trends in the amount of teaching time spent on the various programming languages can be noted.

Table 3.11
Programming language profile (Source: Perth Technical College syllabi)

Programming languages delivered in contact hours	1976	1979	1989	1994
1. Cobol	56	17	18	24
2. Structured Query Language (SQL)	0	4	9	8
3.C Programming.	0	26	23	32
4. Expert System	0	4	5	5
5 Database IV	0	4	9	11
6. Fortran	19	9	0	0
7. Assembler	0	17	18	20
8. Basic	25	0	0	0
9. PL1	0	4	18	0
10. Pascal	0	6	0	0
11. Natural/Adabas	0	9	0	0

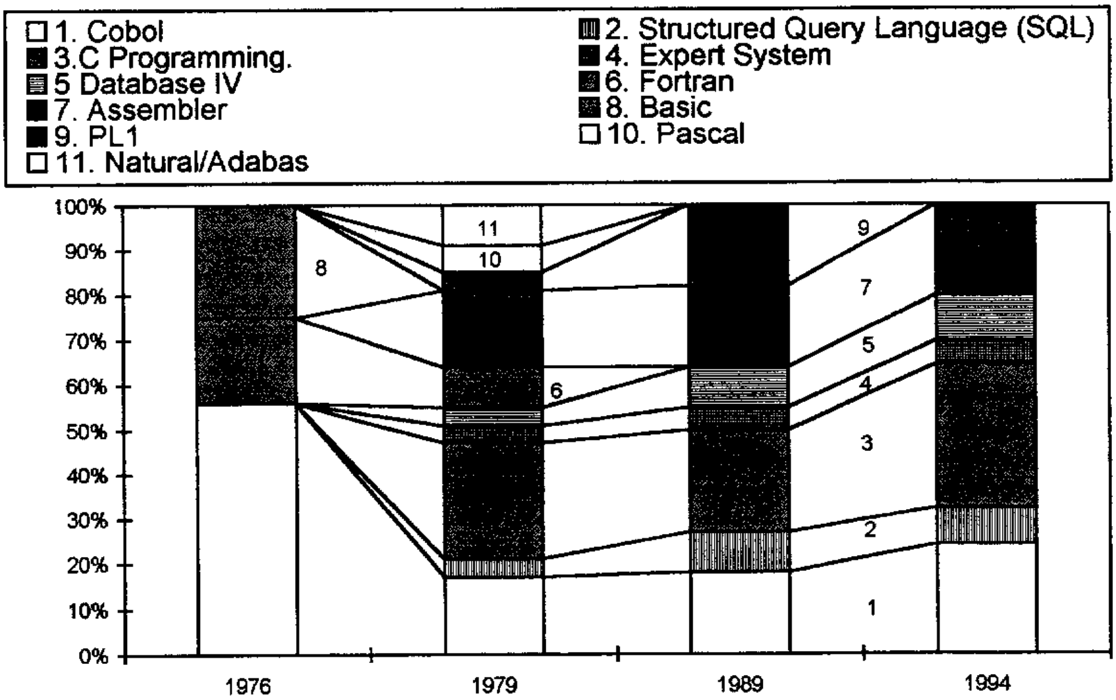


Figure 3.8. Programming language profile *(Source: Perth Technical College syllabi).*

Note: In the Associate Diploma of Applied Science (Computing), the programming core units consisted of: Cobol, Assembler, Database IV, C, SQL. The elective units consisted of: Natural, Pascal, Fortran, Expert Systems and Object oriented programming (C++) which was included recently in the syllabus.

Programming languages such as Basic (8) disappeared from the curriculum after 1976 because it was difficult for programmers to adopt a structured design methodology. After the 1987 semesterisation and restructuring of the course, Pascal (10) programming disappeared. There were difficulties in teaching PL1 (9) programming because of limited training, knowledge and teaching resources related to the IBM AS/400 mid-range computer. On the other hand, SQL (2) & C programming (3) gained in importance to reflect industrial needs. Cobol (1) is still taught because organisations have a large investment in their existing systems and Management Information System (MIS) managers favour to use it in businesses applications.

Other programming languages such as PL1 (IBM), Fortran and Assembler also adopted structured techniques in order to survive. PL1 was taught until 1993 on the IBM AS400 where the software ceased to be annually maintained to save operating costs. Fortran was not offered except in few Colleges. Programming in C was raised in importance and is a more recent language adopting the functionality of the structured design approach.

After 1979, investigation of each programming syllabus revealed the necessity of a structured approach across all the programming languages. There was also a need to separate functions into relatively independent modules to use effectively and efficiently computer programs. The syllabus specified quite clearly that programs had to, therefore, appear as a hierarchy of modules each one of which needed to be more abstract than the one below it. The main function of the program was to describe briefly the major actions of the program to be performed.

Cobol programming is the only subject which survived in industry and is still taught today in the Associate Diploma of Applied Science (Computing) and in the National curricula modules. A detailed study of the syllabus shows that Cobol was semesterised at the beginning of 1979. A comparison between the content of the two syllabi dated 1976 and 1989, which was the last time the syllabi was substantially updated, revealed that the latter material was more complex because it emphasised on highly abstract concepts such as top down design methodology. In 1989, the use of charting techniques such as pseudocode and Nassi Schneidermann charts, use of libraries with copy statements in Cobol programming, revealed that the syllabus promoted the concept and the use of structured design and programming. This fact also confirmed that in order to survive in industry, Cobol compilers had to adapt to the top down design paradigm and that is why Cobol is still very much used in business organisations.

In programming languages, 3GL played an important role in the curriculum (44%) but its use depended on the type of software and hardware platforms in the College. C programming is used by several Colleges but sometimes they may be based on micro-computers or mid-range computers. At the Central Metro College of Perth, because of its diversity of hardware and software platforms, programming in C was taught in a variety of software environment such as the VAX running under VMS and on the Unisys running under Unix. PL1 was offered on the IBM AS/400 hardware platform running under the IBM AS/400 Operating System.

3.4.4 Evolution of database software and Fourth Generation Programming Language (4GL)

This section examines the important role of some database software and trends which are affecting the computer professionals in industry. This information will be used to assess whether the curriculum changes and the college computer platforms were kept up to date and relevant to industrial demand.

Database software technologies started to appear in the middle of the 1960's with IBM announcing its product called Information Management System (IMS). IMS software was a hierarchical database for large and expensive machines. A different type of database appeared a few years later which used a network approach. In the early 1980's, a new database system based on relational algebra gave birth to a new fourth generation language called Structured Query Language (SQL). SQL allows users to create and manipulate easily their own data base because it is an English type of language. Today, SQL has been extended to include more facilities in the area of semantic modelling. SQL is a non-procedural language and claims are made that it is close to a natural language for users using distributed processing. Eventually, database languages will handle not only traditional data, but also complex objects found in various applications such as in CASE, computer integrated manufacturing systems, and medicine (Date, 1995, p. 631).

In 1979, SQL programming language, a 4GL programming language was introduced in the syllabus because of new IT trends in software development. This programming language is still growing in popularity and is becoming the industry standard in programming. In the middle of the 1980's, CASE tools such as Oracle appeared on the market as important productivity tools but to generate programming code. At the beginning the 1990's, emergence of commercial distributed database and client/server systems such as DB2, Oracle, Ingres and others, started to appear on the market (Date, 1995, Chapter 21: Kroenke 1995, p. 506).

Table 3.12

Market share of DBMS in percentage (Source: Strategic Research, 1995)

Market share of DBMS in percentage	1994	1995
DB2/AS 400	22.1	22.9
Oracle	11.9	12.8
Ingres	7.4	6.6
Informix	5.5	5.8
RDB	5.1	4.8
Progress	3.9	4.1
DB2 mainframe	3.1	3.2
Other suppliers having between 3.8 & 1.8 %	6.5	8.7
IMS	1.8	1.7
Others suppliers not listed with less than 1.8 %	33.7	29.4

Table 3.13 illustrates a recent survey of Database Management Systems software (DBMS) and hardware platforms used in Australian private and government businesses.

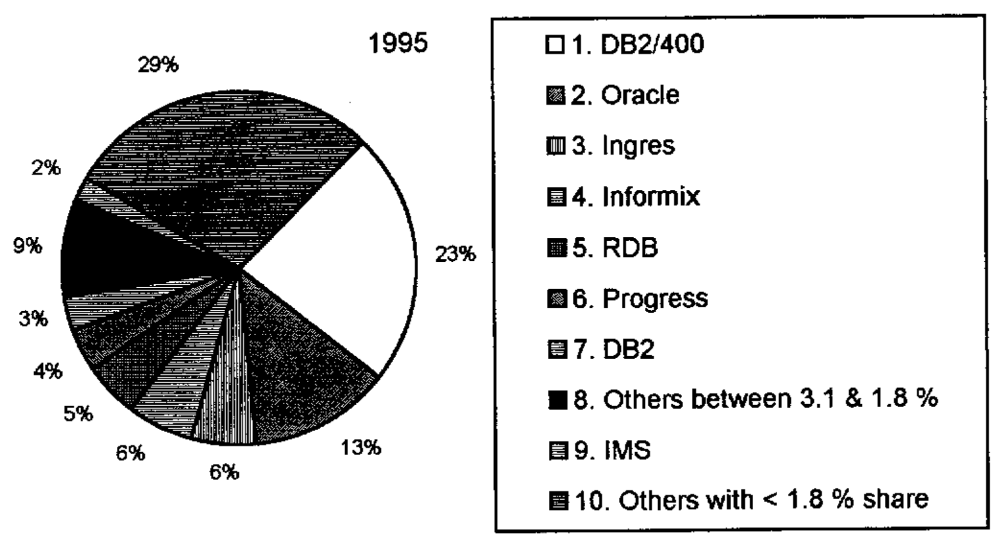


Figure 3.9. Percentage (rounded) DBMS market share in 1995.

Figure 3.9 illustrates that DB2/AS 400 (IBM platform dependent) is currently the market leader (23%) in relational database software, followed by Oracle (13%), Ingres (7%) and Informix (6%).

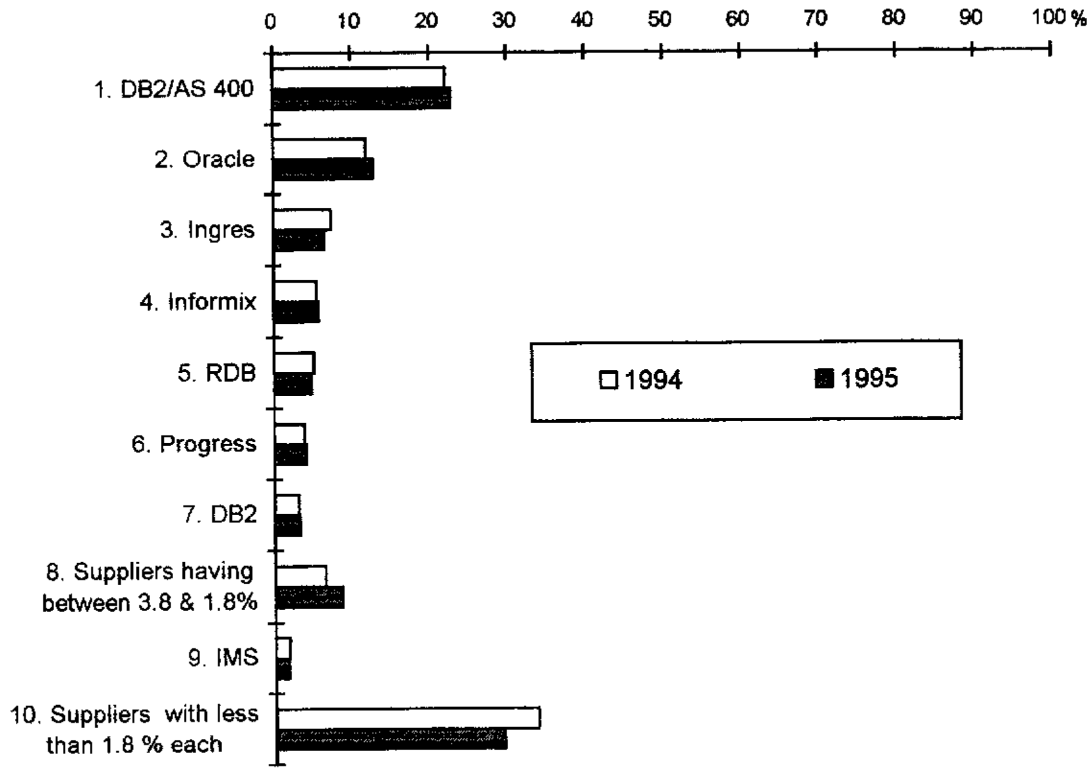


Figure 3.10. Comparison of market share trends in 1995 and 1994.

Figure 3.10 shows IBM DB2, Oracle, Informix, RDB, and Progress are increasing their market share in relational database software. On the other hand, IBM IMS hierarchical database running on the mainframe which dominated the market in the 70's and 80's, is further losing market share. IBM DB2 relational database is however increasing its market share. Relational database such as Oracle, Ingres, Informix, RDB, Progress and DB2 represents 55.4 of the total market share. Skills learned in one of them makes it portable because these database softwares are based on the Structured Query Language (SQL) which is regulated by the American National Standard Interchange (ANSI) organisation.

3.4.5 College software and hardware platform profile

This section provides information about database software packages used in the curriculum. The following table illustrates the range of database software the college has installed but which has not necessarily been used by teachers.

Table 3.13 reveals that the college relies on one relational database. That is Oracle running on the VAX under VMS. Dbase III++ which is not a relational database, is still taught but should be superseded in 1995 by the introduction of Microsoft new product: MS Access (v 2.a) which is a relational database for personal computers and extensively used in the CBT course.

Table 3.13
Comparison between industry and software/hardware used by the College, in 1993/4

Software and hardware used by industry	Software installed by the College	Software used by teachers
Oracle running under Alpha/VMS	Yes	Yes
Ingres running under VAX/VMS	Yes	No
RDB running under the Alpha/VMS	Yes	No
SQL/IBM AS400 (Cobol &PL1)	Yes	Yes
Unisys (Unix & C programming)	Yes	Yes
Dbase III++	Yes	Yes
IBM/IMS	No	
Microsoft products (Windows, Word Processing, Excel & Access)	Yes	Yes

3.5 Students' performance and pass rate

There has been a criticism that the syllabi which is content laden was not cost effective because of the students' high attrition rate at the end of each academic year. In an internal memo, management argued that the course tended to emphasise mainly programming skills and therefore was too rigorous. Management also considered that the course had an academic level of standard similar to universities. DEET's (1992, vol.2, p. 24) report stated that the attrition rate remained too high in the Associate Diploma in Computing, but it did not provide figures for each State. To reduce the students' attrition rate, the report recommended the use of selection procedures since the "first come first served" entry to the course was a factor contributing to the failure rate. The sector never implemented these recommendations.

To illustrates how well students (61) had performed in various final year subjects since 1990 over a 5 semester period, the attrition rate was calculated. The following core subjects were taken into account:

TP102: Technical Programming in C
DS102: Data Structures (C programming)
CS203: Computer Systems
SA203: Systems Analysis (uses Execelerator)
CC204: Computer Communications
AS204: Applied Systems (project)
PA203: Programming Assembler
SP204: System Programming (assembler)

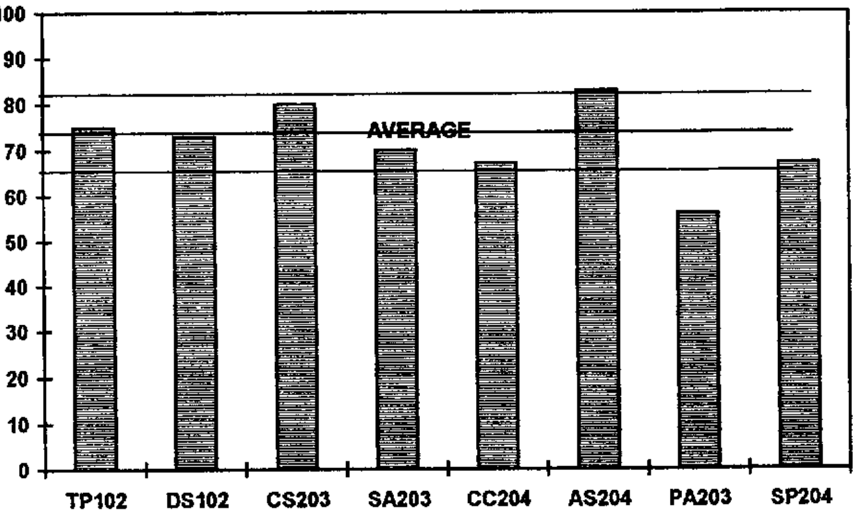


Figure 3.11. Students' pass rate over 5 semesters (Source: Unpublished study area report).

Applied Systems and Programming Assembler showed the greatest deviation from the mean. The reasons for this probably are that Applied Systems 204 has no examination, is assessed on group project work, builds directly on prerequisite subject material and is a final fourth semester subject. Programming Assembler 203 has an examination, but does not involve group project work. It is also a third semester subject and has a different relationship to its prerequisite, since it does not use the subject material directly, but builds it indirectly on structured design concepts.

3.6 Pedagogical approach

3.6.1 Curriculum model based on the syllabi and teaching guides

In the early 1970's, there were no syllabi in the Computing Department at Perth Technical College. The first syllabi appeared only with a vague list of contents at the beginning of the 1976 academic year. In comparing the various syllabi of Cobol programming, teachers had to cover more material and more complex topics in the classroom in the 80's and 90's. In the 1970's, there was no syllabus. The first syllabi in 1976 were vague and required an experienced computer systems analyst or programmer to teach the material. At that time, it was the department's policy to employ teachers with industrial experience. In 1979, the syllabi were more specific in terms of listing facts.

Kangan (1974) was very critical of teaching methods of the sector and stressed that they needed to be improved. The curriculum development and process in all fields needed to address many issues such as teaching methods, syllabi which contained only a list of facts instead of a task analysis of occupation. There were also issues related to the accreditation between States and between the sector and universities. The question of recognition of prior learning and duplication of courses needed to be addressed.

In February 1977, the first computing syllabi were published systematically by the head office of the then named Technical Education Division (TED) of WA, which later became Technical and Further Education (TAFE). But, as far as the syllabi were concerned, it listed only the facts that students needed to learn. It was reported in a interview with the Head of Department that teachers had a lot of freedom for covering and presenting the material to students in the early days. A teaching guide, introduced in 1989, recommended a sequential plan of facts that the students had to learn over a period of 36 weeks. At that time, subjects were delivered over one academic year. Comments in the guide were vague such as: "Make sure that students get plenty of practice". Furthermore, practical work on the computer terminal was limited because Colleges did not have on-line terminals. The practical work consisted mainly of having students' programs checked on the desk by teachers. Teachers spent long hours assessing students' logic and provided them with insufficient and late feedback information.

It was in 1979 that the syllabi became much more explicit and specific in terms of subject matter (An example of the latest version of the Database Design 102 syllabus (1993) is attached in Appendix A). In the syllabus, note that knowledge was described as a structure of concepts. For example, students had to learn not only terminology but a structure of relational database and inter-related concepts such as Entities, Attributes, Tuples and Domain. Content was organised sequentially in such a way that definitions of terminology were learned first, followed by basic principles such as relations or tables and their manipulation in 4GL programming. This programming stage was essentially concrete. Abstract concepts such as the normalisation processes of designing a database, access and efficiency considerations was taught towards the end of the semester course. In addition to the structured content (or cognitive structure of the discipline), the syllabus had to state the activities to be learned in terms of performance objectives. Verbs such as design, construct and implement were used and linked to the content to be learned. Students needed to show specific educational outcomes. For example, the syllabus stated that students had to construct semantically and syntactically correct SQL statements based on the prerequisite subjects and additional new features listed in the syllabus.

Computing subjects in the 80's and 90's were more rigorous because they were integrated with other theoretical and abstract disciplines. For example, the study of Cobol programming needed strong theoretical background on structured design. The learning of relational database subjects required grounding in relational algebra, learning in data structures required basic concepts in statistics and probability to understand the processing of hashing files (random access files). The importance of quantitative analysis also was emphasised because of its application in several business systems such as forecasting, stock control, production planning and a range of other business applications.

In an interview, the Head of the Accounting and Data Processing Department, as it was called twenty years ago, recalled that teachers had a lot of freedom in teaching their topics. He said that standards of the material taught varied greatly from one teacher to the other. Most of the time teaching was based on formal lectures. When the computing department started, syllabi were vague and there was no teaching guide. Usually, teachers were employed directly from Industry to teach computing subjects. But, some qualified secondary teachers who did not have a background in computer programming handled the Mathematics or Science areas.

Kangan stressed that the sector needed a more systematic and team approach to curriculum. Also, past, recent and current students had to be involved in course development and that students' opinion, feedback and evaluation had to be sought. The chairperson of the first committee Kangan, who was Secretary of the Federal Department of Labour, proposed mainly an increase in capital expenditure. But, because of Federal elections in May 1974, the government postponed any major decisions and appointed Associate Professor E Richardson of Macquarie University as chairperson of the TAFE committee to produce the second report. It must be noted that most of the members sitting on the committees were public servants from the ministry of education and trade council with the exception of the chairperson who was an academic.

It was in 1977, following the implementation of the new syllabi and the installation of new computer equipment (Richardson, 1975) that teaching started to change. Richardson emphasised the importance of curriculum design, but recognised that teachers had lacked the opportunity to acquire formalised professional qualifications and the release of staff to undertake professional studies and experience with other institutions. The Richardson report suggested that the sector neglected areas of teacher's training, students' work experience, the application of computers for educational purposes such as Computer Managed Learning (CML) and Computer Assisted Instructions (CAI), and access to computing for students undertaking courses. The report also stressed that students needed to develop programming ability in scientific and commercial languages. Furthermore, it stated that it was important for students to understand problems that occur when computer technology is introduced into the business or industry. In all the courses, the committee wanted to see students aware of the social implications of data processing and to have such issues included in the syllabi. Finally, the committee recommended the use of computer terminals as an interactive mode in order to facilitate and encourage learning.

In terms of curriculum development, the report suggested a closer liaison between curriculum development units at head office and implementation committees in the field. Teachers also had to play a bigger role in conducting industrial surveys and developing curriculum. The report recommended that close contact needed to be maintained with industry to continuously update courses and equipment and use a more systematic approach to the educational and training system of the sector. This new educational philosophy was based on the training model system which proposed a highly structured approach to curriculum development. The new principle of learning was also based on the concept of immediate reinforcement to encourage learning through the use of technology (Kangan, 1974; Skinner, 1953). If the technology was used appropriately in the classroom, then it will motivate, support and promote design and problem-solving skills.

The Dormer report (1983) wanted to introduce new awards: Certificate, Higher Certificate, Diploma and Higher Diploma (being the highest level). Dormer suggested also more use of IT in the curriculum and stressed that courses had to be modularised but noted that principals in their submission expressed concern at the costs of extensively converting courses into a modular form. Curriculum development was centralised at head office. Also, there was little liaison between curriculum development units at head office and implementation committees in the field. In addition, the report stated that teachers did not participate in conducting industrial surveys and were not even involved in curriculum development. At that time, teachers did not maintain a close contact with industry to update courses and equipment continuously. The Dormer report suggested a policy of human resources consisting in filling vacant positions by employing someone from industry in order to break the monastery system of the sector. On the question of curriculum planning, development and implementation, the Dormer report proposed a three phase system approach. The planning phase had to be based on a needs' analysis, data gathering and syllabi writing. The implementation phase addressed the necessity to involve the teachers when curriculum and syllabi are changed. The evaluation phase consisted of the necessity to measure the effectiveness and efficiency and the integration of students' needs, teachers' and employers' opinions.

Dormer's policy recommendations on curriculum development were partly implemented in the Information Technology area. Some short surveys were conducted by the various Colleges in the 80's (Technical Extension Services and Perth Technical College), but not at regular intervals, to detect industry changes, course relevance and graduates' satisfaction levels. However, in the middle of the 1980's some of the syllabi such as the Cobol and database syllabi started to be upgraded. For example, the emphasis on the old traditional flowchart techniques was abandoned and new methodologies and programming techniques such as Nassi-Schneidermann diagrams and pseudocode appeared in the syllabi. Soon afterwards, a more modern top/down design approach adopted by the computer industry was included in the various programming syllabi.

It was also in the mid 80's that a considerable number of IT teachers joined the computing department in relevant colleges and had some modern exposure to structural approach to problem-solving in the areas of IT. A decade of experience proved that analysts and programmers who followed the top/down approach, no matter what language they used, were successful at writing programs that were easier to get the system and the program correct first time, to understand the system and read the programs, to change the system or programs and to take apart and re-use their sub-systems/programs compared with other people who do not understand or practise this structured methodology.

Finn (1991) recommended a new post-compulsory curriculum to promote problem-solving skills. This was a new challenge for curriculum planners to develop new teaching strategies to develop students' problem-solving skills. To achieve the above goals, Finn recommended key competencies in problem-solving and transfer of those skills but he did not address specifically the question of how to foster problem-solving skills. This question of Competency Based Training (CBT) was addressed in the literature review in Chapter 2.

DEET's (1992) report acknowledged that teaching is not simply a question of passing on information to learners and expect that understanding will result, but to develop students' problem-solving skills. This report thus acknowledged the importance of problem-solving skills which play a critical role in training information technologists

Furthermore, the delivery of programming courses in 1994 revealed that half of the lessons were allocated to practical work using on-line computer terminals. The curriculum was based on the training model and teachers were encouraged to follow the following steps:

- ensure the prerequisite learning is achieved;
- the performance objectives are achieved;
- goals are broken down into tasks;
- tasks are broken down again into smaller components;
- sequencing the tasks has to ensure adequate transfer;
- produce outcomes or work on the computer terminal; and
- transfer is expected.

The above training model approach imposed a great deal of structure on the learner. With the assistance of computers, computing teachers covered more classroom material and complex topics than their predecessors.

3.6.2 Modularisation of subjects

After the recommendation of the Dormer report in 1983, there was pressure mounting on the sector to introduce a modular approach to subjects. Management argued that subjects divided into modules made the course more efficient and flexible for the department. But at that time College principals were not in favour of modularisation of the curriculum because of lack of resources. Also, management wanted to implement a Computer Based Learning (CML) approach in order to rationalise computing courses in WA. The Victorian Outer Eastern College computing course was one option that management had chosen to implement but there were doubts about the quality of the curriculum and the instructional material (e.g. internal memo from the Industry Employment Training Council).

3.6.3 Curriculum framework and processes

Anderson and Jones (1986) investigated a process of curriculum development of the sector called the Dacum (Developing a curriculum). This approach had its origin in the systems approach to training. It is basically an occupational analysis followed by a task analysis which is then used for the systematic development of the curriculum through workshops. The workshop requires the appointment of a facilitator, and the selection of an occupational area (e.g. computing), in order to identify specific skills, define duties, establish levels of competence for each skill, rate the importance of the skills and record conclusions. A workshop may consist of up to 24 people including representatives from industry, teachers and public servants.

Various forms of Dacum have been used by the sector since 1970. According to Anderson and Jones (1986), the WA department of education used a different variation of Dacum by excluding the teachers from the workshop. They began to be involved only when they were handed the data from the workshop in order to translate the tasks into behavioural objective format (e.g. Students must be able to ...). It is interesting to note that Anderson and Jones recommended that the sector use a different approach called the "Search method" by integrating the various stakeholders such as employers, educators, practitioners and students in the curriculum research process. But, this Search method was never implemented in the sector. Conducting a Search Conference means that the purpose of the workshop is to first explore the forces that will shape the future of the industry (e.g. labour market changes due to competition, hardware and software trends in IT) so that the course aims and content will result in the type of knowledge and skills needed in the future.

3.7 Linking the sector into Industry and teacher training

According to the Kangan and Dormer reports, close contact had to be maintained with industry to update continuously courses, educational material and equipment for the sector in order to promote enough of the relevant skills needed by employers. Courses had to be more relevant to Industry and the sector needed to set up a mechanism to strengthen links with Industry. The above authors suggested a policy in human resources consisting in fulfilling some vacant positions by employing specialists from industry in order to break the monastery system of the sector. This seemed a good idea and needed to be promoted.

In the 1990's there were examples of joint training ventures with organisations willing to participate in training as partners. In NSW, some examples of successful joint ventures in educational and training occurred where large multinational organisations like IBM provided the equipment and material while teachers were trained using modern technology. Joint ventures gave the sector the opportunity to develop research into task analysis of occupation in order to make the content more relevant to industry.

3.8 Australian Computer Society (ACS) requirements and standards

The ACS as a professional organisation had an impact on the IT curriculum development and standard of the course. For example, in 1981, the ACS refused to recognise TAFE computing courses. In a letter to the Director of the department, the ACS raised objections to registering courses without some independent evidence of proper standards. Therefore, it was suggested that all graduating students had to sit the ACS special examination in computing. If all or a considerable majority passed the special examination, the ACS suggested this would provide the evidence of a proper standard. Those TAFE students who passed the ACS examination would also immediately satisfy the ACS qualifications and therefore be eligible for full professional membership of the ACS. The ACS concluded that it would like to work with the sector and the colleges in developing computing courses and examinations.

4. Summary

Trends in computer technology and sophistication in software at reasonable cost, have affected the way jobs are performed in the workplace and over the years, curriculum changes occurred as a result of:

- computer technological innovations;
- multiskilled trends in the workplace;
- Federal and State governments responses to employers' demand;
- pedagogical trends toward "doing things"; and
- requirements from professional associations and the Industry, Electronics & Information Technology and Training Council (IETC).

Computer technological innovations

The structure of the content of the syllabi of the Associate Diploma in Applied Science (Computing) was adapted progressively to reflect trends in information technology and industrial needs to provide a wide range of technical skills. Therefore, appropriate hardware and software platforms were upgraded regularly by the college to reflect the rapid IT changes. For example, Wide Area Networks (WAN) and Local Area Networks (LAN) facilities were introduced into the classroom: relational database technologies, 4GL programming, Unix operating systems and various system and programming methodologies were integrated into the curriculum.

Multiskilled trends in the workplace

Technological innovations also had a profound impact on the type of workers needed by employers. The workplace changes were reflected in the educational goals of the course and the professional level of graduates of the Associate Diploma in Applied Science (Computing). The curriculum was adapted progressively to meet the labour market demand as is indicated by the educational goals of the course offered twenty four years ago being different from those of today. In the 1970's, computing curriculum was designed to provide training specifically at programming and advanced programming level. The curriculum was upgraded significantly to reflect the multiskilled trends in the job market to train not only students in programming, systems analysis and design, but also in project management and leadership. The use of CASE tools for designing computer systems and focus on programming activities (40%) played an important part in the Associate Diploma (computing) to foster problem-solving skills. With the introduction of CBT in 1995, programming activities declined in importance to 19%. But, at the same time, job related activities such as technical writing and documentation techniques increased in importance at the expense of programming languages.

Federal and State responses to employers' demand

In the past, the course outline drew substantially from mathematical and accounting disciplines because it assumed that the former promoted logical reasoning and the last one was required for understanding business management principles. Over the years, there was a noticeable trend to move away from the traditional disciplines in Mathematics, Accountancy and English. In fact, general education dropped from 36% to 14% of the total teaching time. This significant decline in general education and a shift towards technical computer training was accompanied by a simultaneous increase in the entry level of the course. The entry level was increased to year 12 or equivalent levels, with Mathematics and English as additional requirements to meet Universities' standards and articulation.

The syllabi were kept up to date to meet the range of skill required by employers. At a later stage, in addition to the syllabi, the sector introduced teaching guides which expressed sequentially the performance objectives which had to be learned in the classroom. But, these were later abandoned because of a lack of resources.

The curriculum was semesterised in the 1980's and examinations were centralised to maintain standards across the different colleges. The final mark was composed of an internal assessment worth 30% and an examination worth 70%. Each subject with the exception of the one semester unit project, had an examination. To pass, a student needed an aggregated final mark of 50%. Over the years, the average student's pass rate was around 70 %.

Teachers were usually employed directly from industry and trained to be teachers by Curtin University. But, some qualified secondary teachers who did not have a background in computer programming handled the Mathematics or Science areas.

Recently, both Federal and State governments decided to implement the National IT Curriculum based on Competency Based Training (CBT) as described in Chapter 2.

Pedagogical trends toward "doing things" rather than passive learning

Practical work, including design activities such as the use of CASE tools and 3GL/4GL programming, played an important role in the curriculum. Doing practical work with the computer increased and represented about 40% of the total of the course work delivered in the syllabus or content driven model. But, with the introduction of CBT, it decreased substantially and represented about 13% of the total of the course delivered (Table 3.3.1). Furthermore, integration of knowledge and skills was achieved through one semester project unit in the final year programme which represented only 7% of the total teaching delivery of the Associate Diploma in Applied Science course. But, in some Colleges, there were opportunities for students to gain additional practical experience with employers under the supervision of teachers.

Requirements from professional associations and the IETC

Over the years, the number of stakeholders expanded to include members of various organisations such as the ACS, training providers, employers (IETC), universities and TAFE. They played an important role in determining the curriculum model, the shape of the courses and the accreditation of the courses. Their role is also to provide future directions, evaluate new courses and maintain the standards of existing courses. In the past, stakeholders regularly have investigated the standards of examination papers and the appropriateness of the college computer facilities. Often they have collected information to check whether the teaching staff had appropriate qualifications. Teachers needed to be qualified in IT and reasonably experienced before the stakeholders granted and renewed the accreditation of the programme.

Graduates from the Associate Diploma in Applied Science (Computing) who passed the ACS examination and satisfied the ACS qualifications, were automatically eligible for full professional membership. Most of the graduates sat for the ACS examinations and obtained their full professional membership. Usually, Curtin and Edith Cowan University gave advanced standing in their Bachelor of Applied Science/Information Systems of up to eight units or the equivalent of one year of study.

This Chapter has reported on the major influences and changes that have occurred in the IT syllabi/content driven curriculum of the Associate Diploma in Applied Science (Computing) since 1970. This curriculum model had operated for 24 years and was regularly refined.

To assess whether this curriculum model, had positive results, the next chapter will address the questions of graduates' ability to adapt to changing industrial and technological situations and their satisfaction with aspects of their course. The next chapter also addresses the appropriateness of the pedagogical approach and course organisation adopted by the computing department.

CHAPTER 4

AN EVALUATION OF GRADUATES' SATISFACTION WITH ASPECTS OF THEIR ASSOCIATE DIPLOMA IN APPLIED SCIENCE (COMPUTING) COURSE

1. Introduction

From 1972 to 1994, course 9600 offered the Associate Diploma in Applied Science (Computing) award. This award ceased to take new students from the beginning of 1995. The two year fulltime course was based on syllabi which listed in detail the material to be learned. This curriculum model was content driven and the syllabi were updated from time to time by curriculum planners responding to changes in the environment and to a rapidly changing technological workplace. This model emphasised the development of general vocational knowledge and the mastering of the content of the syllabi.

The purpose of this chapter is to analyse, evaluate and discuss the degree of graduates' satisfaction in terms of secondary and university articulation, teaching effectiveness, course organisation and methods of delivery. It also examines curriculum relevance in relation to industry needs, graduates' employment ratio and quality of the computing courses described in Chapters 2 and 3. It is based on two surveys: the graduate satisfaction and destination survey conducted by the National Centre of Vocational Educational Research (NCVER, 1993) and Dawe (1993) of the Western Australian Department of Training (WADOT) and a survey conducted by Arrowsmith (1994) also of WADOT. Data relevant to paraprofessionals stream (Code 3500) and the Associate Diploma of Applied Science in Computing course (Code 9600) have been extracted and analysed. A sample of the survey document is attached in Appendix C.

2. National Centre For Vocational Research (NCVR) research methods

2.1 Instrument

The results from each relevant question are provided, discussed and evaluated in this report. The percentage may not always add up to 100% as some respondents chose not to reply to some questions. The survey was developed by first determining the research questions addressed by this study (Chapter One, p.2). A pilot study was conducted by the NCVER when the survey neared its final form.

From this questionnaire, students' suggestions or comments on the improvement of the curriculum could not be extracted from the database files (SECTION 2 - SATISFACTION WITH THE COURSE, Question 20: SECTION 6 -YOUR COMMENTS). However, twelve students who graduated between 1991 and 1993 were asked to comment about aspects of their Associate Diploma (Computing) course.

The NCVER survey consists of six sections, but the results of only the following five sections are of relevance to this study:

- Section 1: Educational background of the graduates before enrolling in a TAFE course (e.g. entry level).
- Section 2: Graduates' satisfaction with their course (e.g. course organisation).
- Section 3: Employment status of the graduates (e.g. ability of graduates to get a job related to their studies).
- Section 4: Further studies (e.g. graduates' preferences).
- Section 5: Demographic profile of students (e.g. ethnic background).

2.2 Sample size and techniques used

The information relates to students who attended the Central Metropolitan College of TAFE (Perth Campus). The NCVER survey was conducted in April 1993. This sample consists of 18 graduates who completed their studies in 1991 and 1992. The West Australian Department of Training (WADOT) survey based on the NCVER questionnaire was conducted in August 1994 and relates to 1993 graduates. This sample consists of 21 graduates who completed their studies at the end of 1993. In Western Australia, surveys were sent to all the graduates. The response rate to the NCVER survey was 37% or around 3 000 respondents. The WADOT survey of WA graduates was also large. WADOT did send a questionnaire to each student who graduated in 1991/2/3 and received 39 responses out of a total of 82 graduates (48%). This rate of participation is normal. But, to verify the views of the respondents, twelve other graduates were asked to comment about aspects of their Associate Diploma (Computing) course.

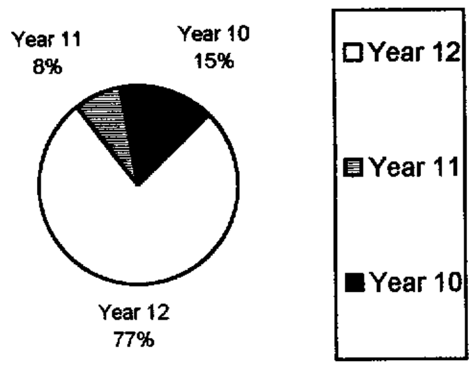
3. Analysis, discussion and evaluation of the responses based on the NCVER questionnaire (see Appendix C)

Section 1:Educational background of the graduates before enrolling in a TAFE course

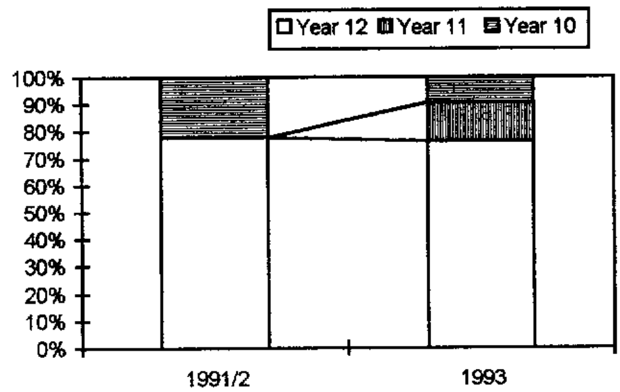
This section deals with the entry level of the graduates before they attended the Associate Diploma in Applied Science (Computing) course.

Question 8: The highest level completed at school

	Year 10	Year 11	Year 12	Total
1991/2	4	0	14	18
1993	2	3	16	21
Total	6	3	30	39



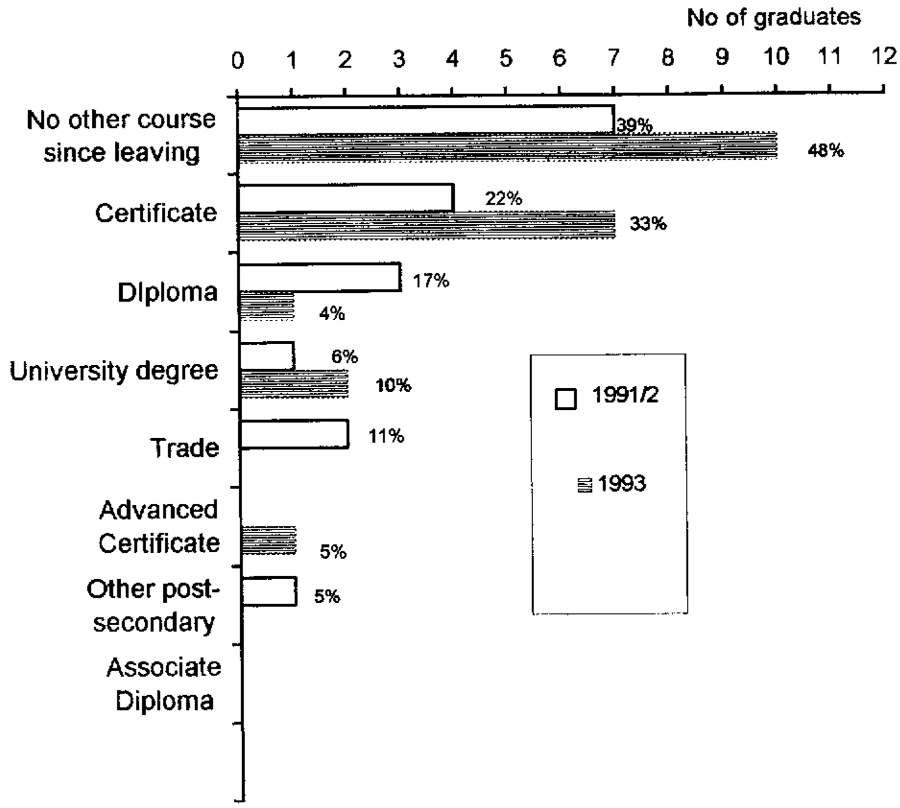
More than two thirds of the students had completed their secondary schooling.



There was no increase in Year 12 graduates between 1991 and 1993. But, there was an increase in the year 11 intake.

Question 9: Highest qualification obtained before the graduates attended the Associate Diploma in Applied Science (Computing) course

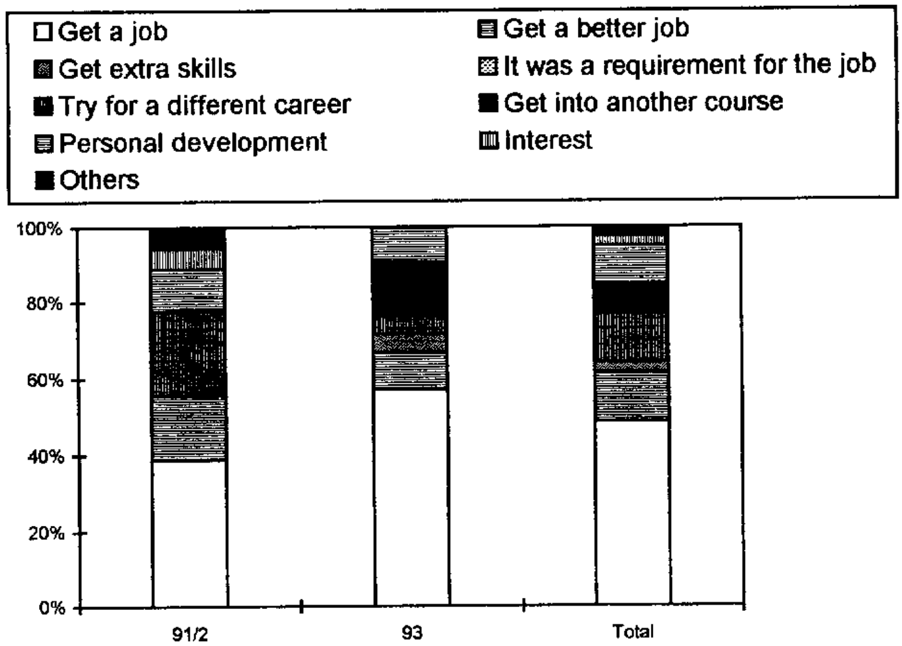
Highest qualification on entry	1991/2	1993	Total
Trade	2	0	2
Certificate	4	7	11
Advanced Certificate	0	1	1
Associate Diploma	0	0	0
Diploma	3	1	4
University degree	1	2	3
Other post-secondary	1	0	1
No other course since leaving school	7	10	17
Total	18	21	39



The table and figure show an increase of students with university qualifications of 4% prior to starting the Associate Diploma in Applied Science (Computing). University students represented 10% of the total students intake in 1993. The course seemed attractive to university graduates wishing to obtain additional computing and practical skills in programming.

Question 12: The most important reasons of undertaking the course of the Associate Diploma of Applied Science in Computing (1991/2 & 1993).

Reasons	1991/2	1993	Total
Get a job	7	12	19
Get a better job	3	2	5
Get extra skills	0	1	1
It was a requirement for the job	0	0	0
Try for a different career	4	1	5
Get into another course	0	3	3
Personal development	2	2	4
Interest	1	0	1
Others	1	0	1
Total	18	21	39



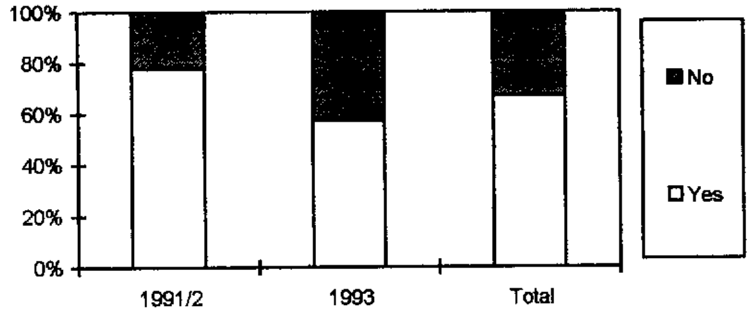
The table and figure show a comparison between 1991/2 and 1993. Most of the graduates attended this course for reasons related to obtaining a new job, improving their current job or gaining extra skills in the computing area (80%).

Section2: Graduates' satisfaction with aspects of their course

This section deals with a range of specific questions related to the Associate Diploma course in Applied Science (Computing). It covers reasons why graduates attended the above course, the satisfaction of the graduates in the methods of delivery of the computing programs, the course accreditation system, teacher effectiveness and course organisation offered by the various Colleges in 1991/2/3.

Question 12: The course helped to achieve the above objective (see Question 11)

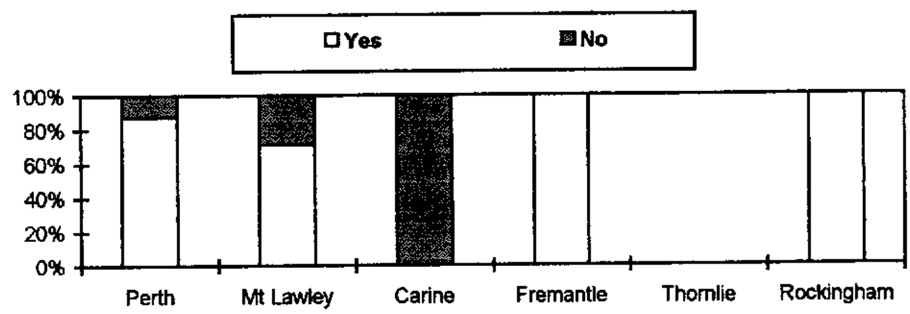
	1991/2	1993	Total
Yes	14	12	26
No	4	9	13
Total	18	21	39



There was a noticeable drop between from 1991/2 to 1993 in students' perceptions of meeting their main objective in undertaking the course (Job related course). This may be due to the fact that the syllabi, software and hardware equipment were not updated on a regular basis to meet industry needs. For example, there was no systematic update of the syllabi from Head Office from 1989 until the Associate Diploma award ceased to take new students at the beginning of 1995 (see Table 3.1 & 3.2). However, the programming languages and college software platforms used in the course were relevant to meeting industrial IT demands. This is discussed in the third chapter (p. 53 & 56).

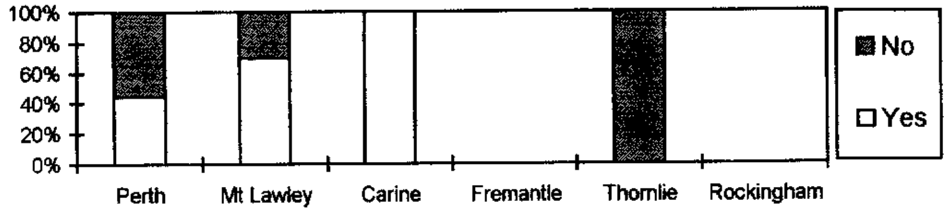
- Perception by Campus from 1991/2 graduates

1991/2	Perth	Mt Lawley	Carine	Fremantle	Thornlie	Rockingham
Yes	7	5	0	1	0	1
No	1	2	1	0	0	0
Total	8	7	1	1	0	1



- Perception by Campus from 1993 graduates

1993	Perth	Mt Lawley	Carine	Fremantle	Thornlie	Rockingham
Yes	4	7	1	0	0	0
No	5	3	0	0	1	0
Total	9	10	1	0	1	0



The main decrease in graduates' perception of achieving their objectives (90% in 1991/2 to 45% in 1993) occurred at Perth Campus. However, Mt Lawley Campus maintained the status quo. The reasons for the decrease at Perth Campus may be due to a lack of software and hardware equipment maintenance and that software and equipment rapidly became outdated. In addition, the IBM AS/400 installed at the Perth Campus had not its operating software updated and therefore could not be used by teachers to teach relevant industrial skills.

Question 13: Method of delivery of this course

Nine students from Perth campus mentioned face-to-face teaching and Computer Aided Instructions (C.A.I.). C.A.I. include computer programming activities as part of the content driven model and teaching strategies to promote cognitive activities and skill transfers. For example, classroom activities based on a framework such as a skeleton program with missing lines was used. This was introduced in 1990 to illustrate stacks, queues, linked lists and tree operations in data structures courses. Later on, several CASE tools (e.g. Excellerator) were used to design, develop and implement system projects.

Question 18: Satisfaction with teaching staff and the course. This question is subdivided into 13 sub-questions (Appendix C).

The following sub-questions are related to teacher effectiveness:

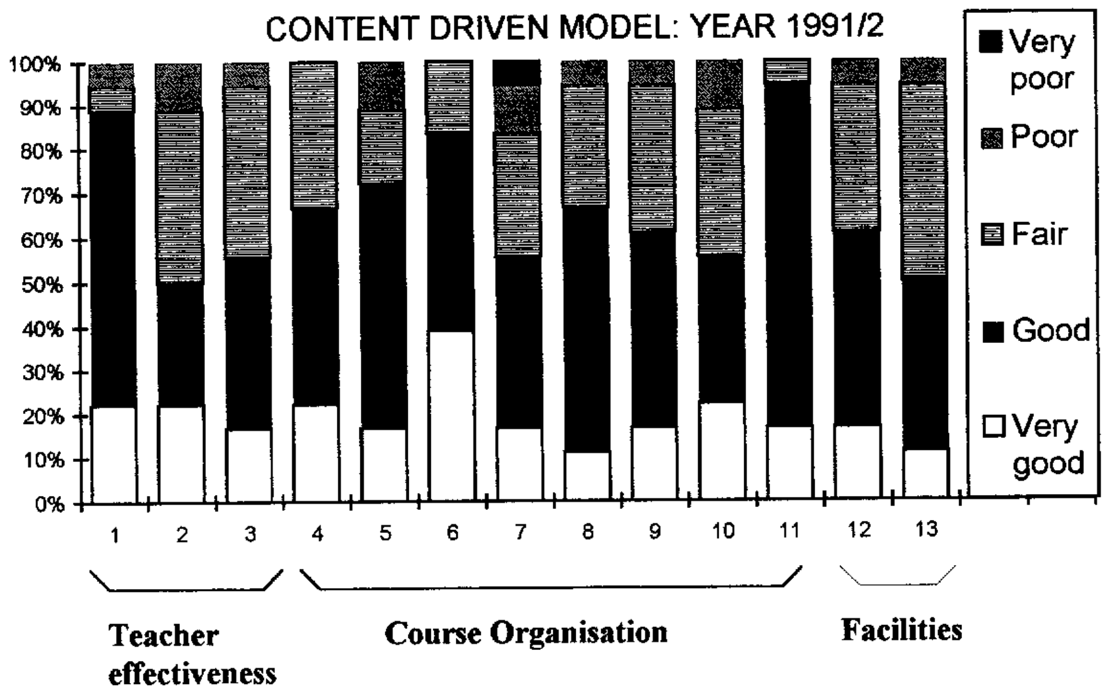
1. Knowledge of content of this course
2. Teaching skills for this course
3. Ability to relate to students

The following questions are related to course organisation and facilities:

4. Content relevant to job
5. Length of the course
6. Balance between theory and practice
7. Availability of options
8. Time and Day classes offered
9. Amount of contact with teacher
10. Printed materials and lesson notes
11. Assessment method
12: Equipment for practical skills
13. Library or learning resources

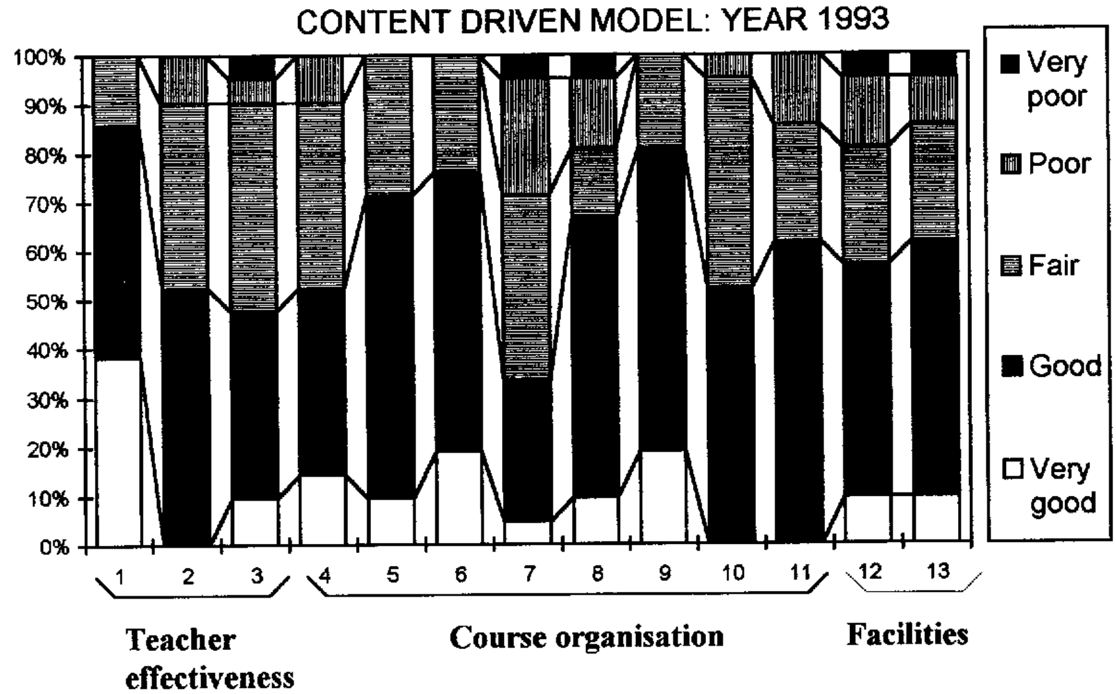
- Satisfaction from 1991/2 graduates about teacher effectiveness, course organisation and facilities

Levels of satisfaction	1	2	3	4	5	6	7	8	9	10	11	12	13
Very good	4	4	3	4	3	7	3	2	3	4	3	3	2
Good	12	5	7	8	10	8	7	10	8	6	14	8	7
Fair	1	7	7	6	3	3	5	5	6	6	1	6	8
Poor	1	2	1	0	2	0	2	1	1	2	0	1	1
Very poor	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	18	18	18	18	18	18	18	18	18	18	18	18	18



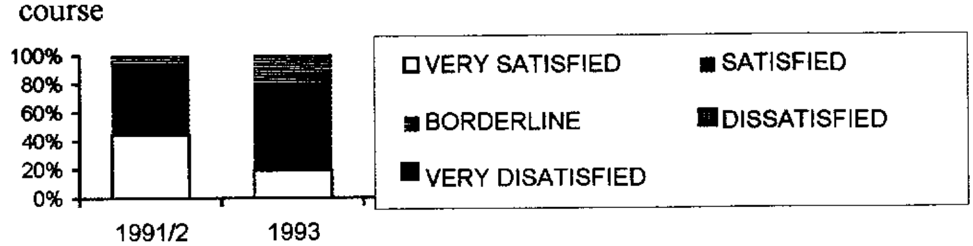
- Satisfaction from 1993 graduates about teacher effectiveness, course organisation and facilities.

Levels of satisfaction	1	2	3	4	5	6	7	8	9	10	11	12	13
Very good	8	0	2	3	2	4	1	2	4	0	0	2	2
Good	10	11	8	8	13	12	6	12	13	11	13	10	11
Fair	3	8	9	8	6	5	8	3	4	9	5	5	5
Poor	0	2	1	2	0	0	5	3	0	1	3	3	2
Very Poor	0	0	1	0	0	0	1	1	0	0	0	1	1
Total	21	21	21	21	21	21	21	21	21	21	21	21	21



The graduates demonstrated high levels of satisfaction (90% including very good, good and fair ratings) with most aspects of their computing course. Particularly high levels of satisfaction with teachers having an excellent knowledge of the content (1) of the course, were demonstrated. But, teaching skills (2) and ability to relate to students (3) declined in 1993 while the overall satisfaction levels remained high. In terms of course organisation, content relevant to job (4), length of the course (5), balance between theory and practical activities such as programming (6) and amount of contact with teachers (9), attracted high levels of approval. However, availability of options (7), Time and Day classes (8) and printed material (10) decreased due to limited resources. In comparing satisfaction levels on assessment (11) between 1991 and 1993, the very satisfied students declined by 18%. This was due to changes in the assessment ratio as described in Chapter Three (Table 3.2, p. 40). In terms of facilities, the equipment use for practical skills such as programming (12) had a significant decrease in the very satisfied corresponding with an increase in the very dissatisfied students. These low levels of satisfaction were related to College computer maintenance policies and may have affected the quality of teaching.

Question 19: Overall satisfaction from 1991/2 & 1993 graduates (39 students) about their course



Further interviews with past Associate Diploma graduates (pp. 68-69), had indicated that they were very satisfied with the course structure and organisation. 80% of them were very satisfied or satisfied with the overall Applied Science (Computing) course, but there was a drop in the highly satisfied graduates from 1991 to 1993 related mainly to changes in the assessment method and computer upgrades and maintenance policies affecting the syllabi and the quality of teaching.

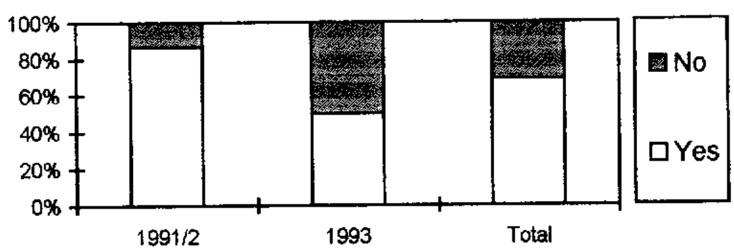
Section 3: Employment status of the graduates

This section deals with the employment questions of graduates, particularly the ability of graduates to gain jobs related to their qualifications in the areas of computing. In this section, the employment ratio is calculated to measure the effectiveness of the program of the Associate Diploma in Applied Science (Computing). This ratio is an effective measure of the quality of any program in vocational education and training.

Note: The questions relates to 1991/2 and 1993 graduates who obtained a job before the first survey conducted in April 1993 and the second survey conducted in early August 1994, respectively.

Question 24.1 This question finds out whether the working graduates had a job before the survey conducted in April 93 and August 94. The job must be related to the course that the graduates had just completed.

Question 24.1	1991/2	1993	Total
Yes	13	7	20
No	2	7	9
Total	15	14	29



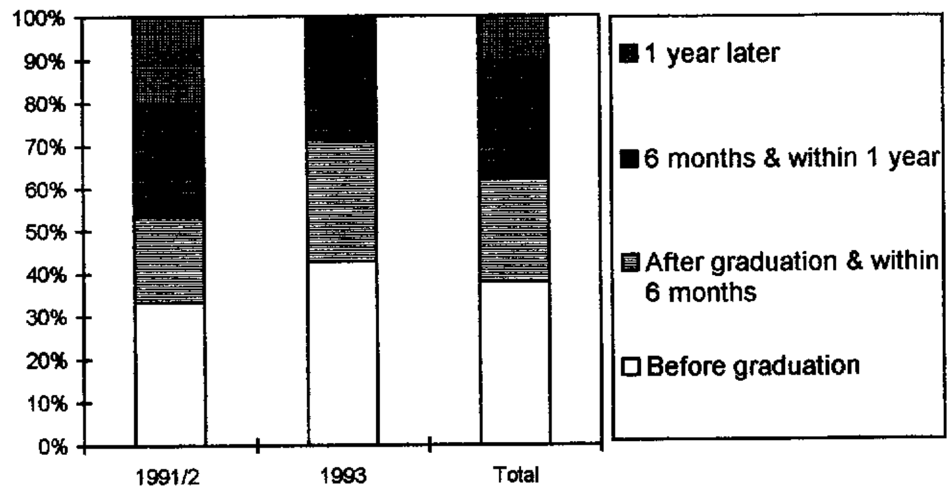
The above figure illustrates that 90% (1991/92) and 50% (1993) of working graduates were employed in jobs related to the course. In comparing 1991/92 and 1993, there was a decrease in working graduates, having obtained jobs related to their course. At this stage, there are no valid explanations which may have caused this. One assumption is that graduates may have found it more difficult to obtain relevant jobs in a very competitive and stagnant IT market during 1993. The other assumption is related to the appropriateness of syllabi, software and hardware upgrading to provide graduates with opportunities to obtain jobs.

Question 24.2: This question relates to the percentage of graduates who were still seeking work related to their course of study at the time of the surveys (April 93 and August 94).

There were two graduates in 1991/2 and one graduate in 1993, still looking, at the time of the surveys, for a job related to their course.

Question 25: This question allows the calculation of the employment ratio for 1991/2 and 1993 graduates.

	Before graduation	After graduation & within 6 months	6 months & within 1 year	1 year later	Total
In 1991/2	5	3	4	3	15
In 1993	6	4	4	0	14
Total	11	7	8	3	29



The table and figure illustrate how long it took graduates to obtain a job related to their course before, during or after their graduation. The figure indicates the success of graduates in seeking jobs related to their course. In 1993, more students had a job before graduation. Most of the 1993 graduates were employed in their field of study within 1 year. About 20% of the 1991/2 graduates were still looking for a job, one year later.

Further detailed analysis shows that about 30% of students were employed in a new or different course related job to the one held before they commenced their study.

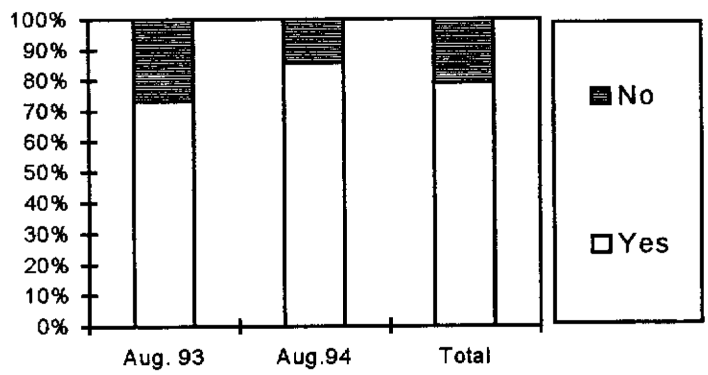
Calculation of the employment ratio is as follows (1991-1993):

- 38% of the respondents had a job or managed to get a job related to their course before they completed their course.
- 24% of the respondents had a job related to their course within 5 months of the completion of their course.
- 28% of the graduates had a job related to their course between 6 months and 1 year after the completion of their course.
- 90% of all graduates had a job within 1 year of completion of their course.

The average employment ratio within a year for graduates employed in a job related to their course is around 90%. This demonstrates that the Associate Diploma programme was very successful.

Question 26: Graduates had a new or different job to any held before they commenced the course.

	August 93	August 94	Total
Yes	11	12	23
No	4	2	6
Total	15	14	29



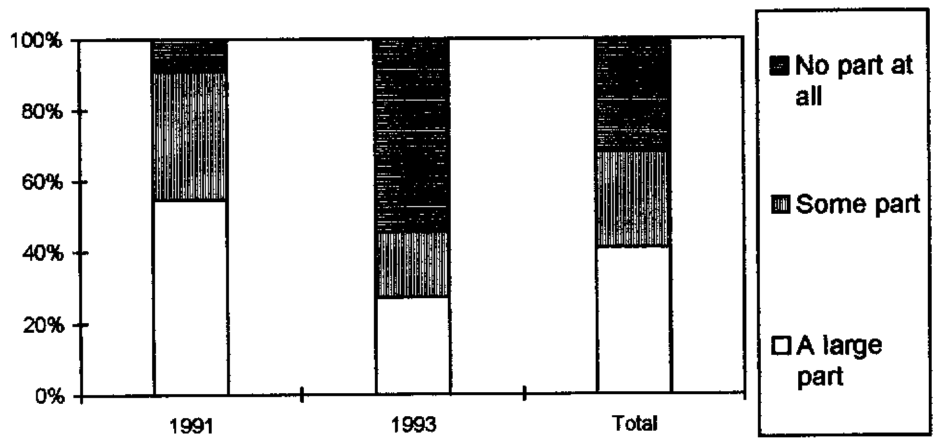
More than 70% of the graduates had a new or different job to any held before they commenced their course between the surveys held in August 1993 and 1994. After interviewing three graduates, they stated that they were offered more important IT positions by their employers.

	April 93(WA)	Aug 94 (WA)	CMC 94
Yes	50%	53%	56%
No	44%	0%	0%
Unanswered	6%	47%	44%

Graduates from the Central Metropolitan College (CMC) of Perth did marginally better (56%). Overall, there was little change between the 1993 and 1994 surveys.

Question 26.2: The course played a part in gaining a job.

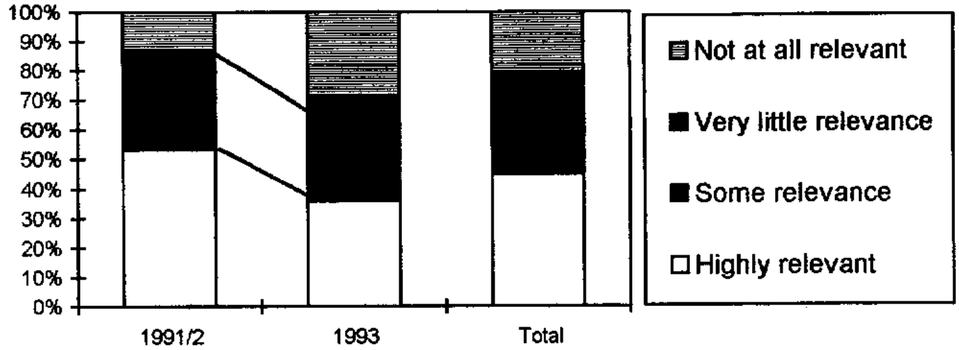
Graduates	A large part	Some part	No part at all	Total
1991	6	4	1	11
1993	3	2	6	11
Total	9	6	7	22



The table and figure illustrate a decrease in the part played by the course in obtaining a job (A large part). On average, about 70% of the course played a part in gaining a job. There was a decrease from 90% in 1991/92 to 50 % in 1993. This decrease may be due to the lack of consistent syllabi, software and hardware maintenance policies.

Question 27: Relevance of the course to the job listed in the survey conducted during April 93 and August 94.

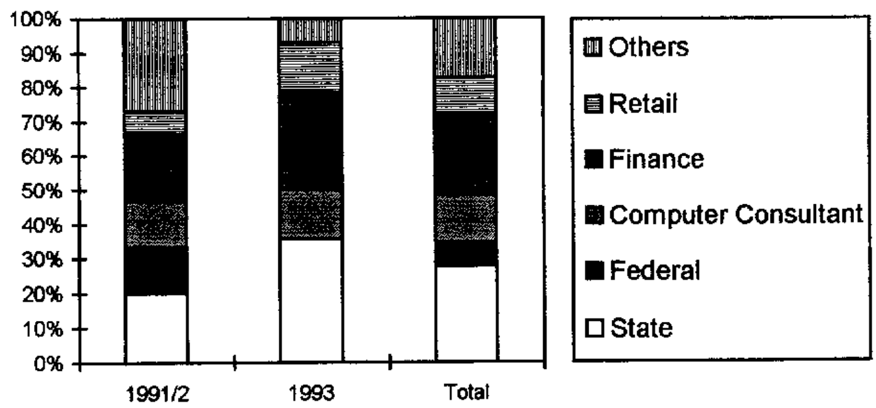
	Highly relevant	Some relevance	Very little relevance	Not at all relevant
1991/2	8	5	0	2
1993	5	4	1	4
Total	13	9	1	6



The overall Central Metropolitan College (Perth) course relevance to jobs is 78% according to the 1991/2 and 1993 graduates. There was a decrease in the course relevance to jobs, perceived by 1991/92 and 1993 graduates. It must be noted again that this may indicate that the syllabi, software and hardware were not adequately maintained to meet industrial needs. On average, over the two years, the course was highly or had some relevance (78%) to the job that graduates performed.

Question 28.a: Graduates employment by industry types.

	State	Federal	Computer Consultant	Finance	Retail	Others
1991/2	3	2	2	3	1	4
1993	5	0	2	4	2	1
Total	8	2	4	7	3	5

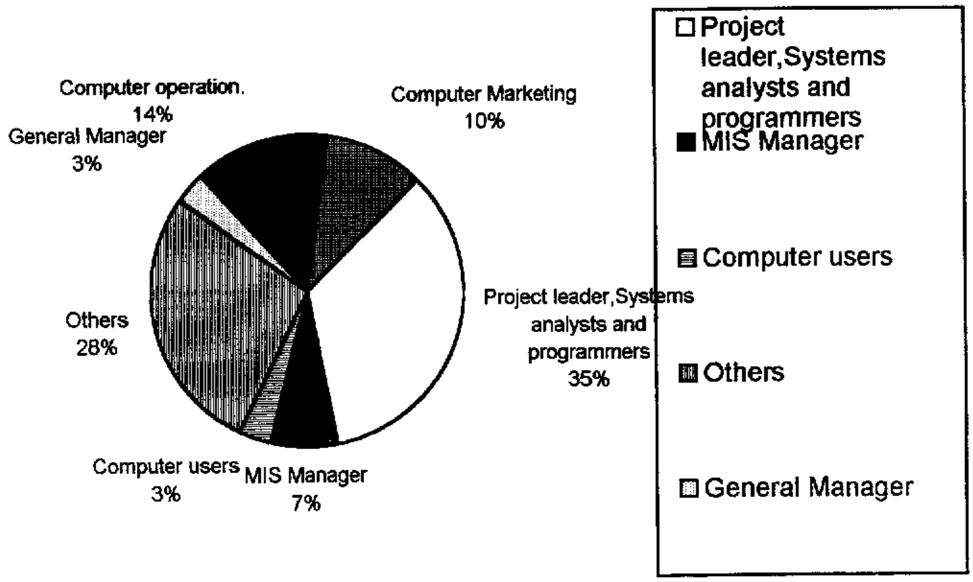


About one third of 1991/92 and 1993 graduates surveyed worked for the State or Federal government which indicates that future surveys need to consider their opinion in terms of curriculum and course changes.

Question 28.b: Occupation or job title of graduates.

	(a)	MIS MGR	Users' area	Others	Software manager	Computer Operation.	Sales
1991/2	4	2	1	4	1	3	0
1993	6	0	0	4	0	1	3
Total	10	2	1	8	1	4	3

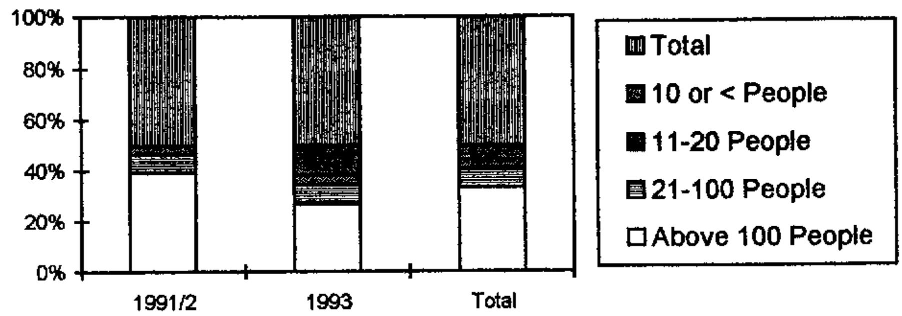
Note: Column (a) is related to the following titles: Project leader, systems analyst, systems and application programmer.



There were 10 graduates who did not respond to this question. The majority of graduates were employed at different levels of the computing profession. The positions performed ranged widely: General and MIS specialist managers, project leaders, systems analysts, systems and application programmers, computer marketing, user supports and other related clerical computer activities. Two graduates were employed as general managers in a software house. The largest number of graduates was employed as project leaders, system analysts or programmers. This means that the content driven curriculum had achieved the educational objective of successfully training IT professionals as project leaders, systems analysts and programmers. Also, these graduates had adapted easily to the rapid technological changes (e.g. introduction of relational database and data communications software) which prevailed between 1990 and 1994.

Question 28.d: Organisation size

	Above 100 People	21-100 People	11-20 People	10 or less People
1991/2	11	2	1	0
1993	7	2	1	3
Total	18	4	2	3



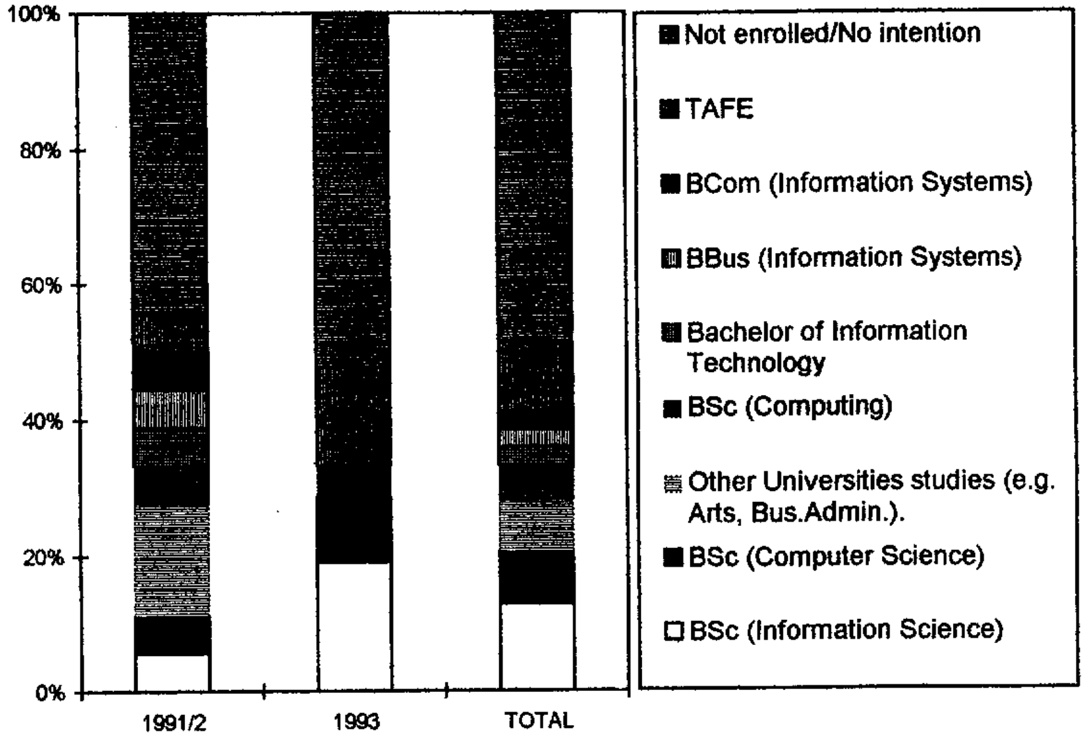
About 40% of the graduates worked for medium to large size companies. This fact has some important implications for the type of employers who need to be surveyed to have their requirements satisfied. These organisations need graduates skilled in large and small systems, a range of operating systems (MVS, VMS and PC based operating systems) and databases software (DB2, Oracle etc.) and different hardware platforms (e.g. Vax, AS400, Unisys, 486's etc.).

Section 4: Further studies

This section deals with university accreditation for graduates who completed their studies in 1991, 1992 & 1993. It provides the Computing Department with important information about the graduates preferences in furthering their studies.

Question 30.a: This question illustrates the preferences of degree courses chosen by graduates enrolled or intending to enrol in further studies.

List of preferences of university degrees	1991/2	1993	TOTAL
BSc (Information Science)	1	4	5
BSc (Computer Science)	1	2	3
Other Universities studies (e.g. Arts, Bus. Admin.).	3	0	3
BSc (Computing)	1	1	2
Bachelor of Information Technology	1	0	1
BBus (Information Systems)	1	0	1
BCom (Information Systems)	1	0	1
TAFE	1	3	4
Not enrolled/No intention	8	11	19
Total	18	21	39

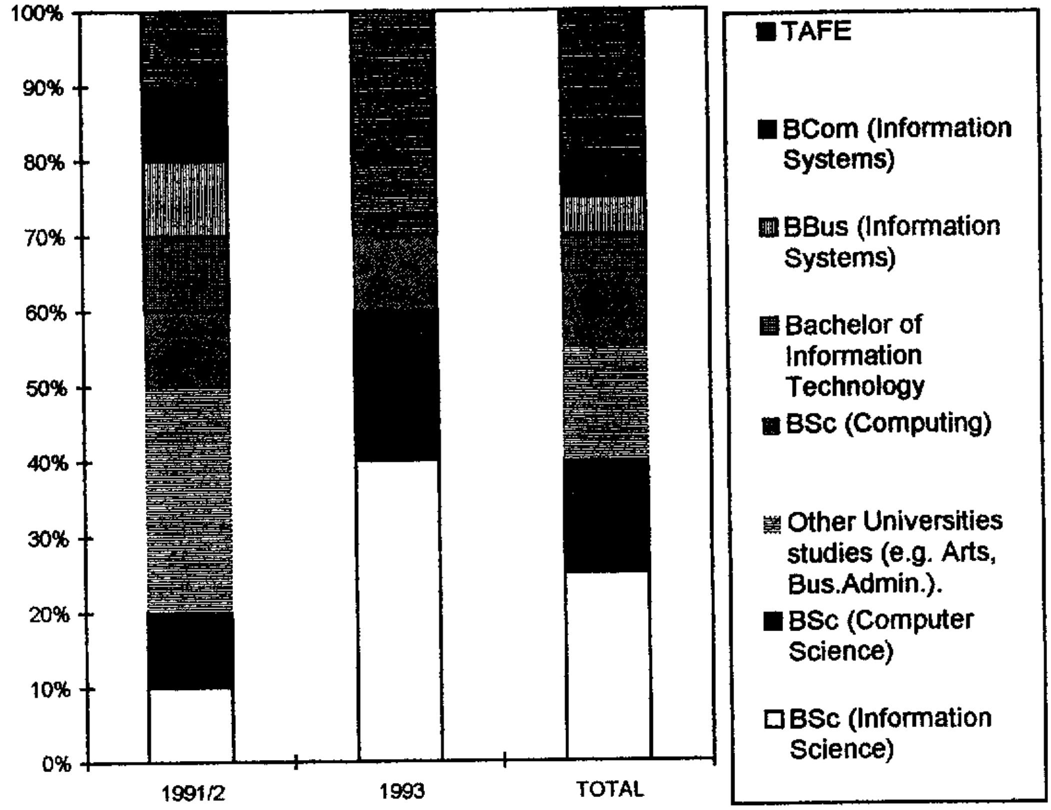


The above table and figure indicate that 19 graduates out of 39 had no intention or were not enrolled in further studies. A very small percentage is interested in further studies at TAFE.

Graduates interested in further studies

List of university degrees	1991/2	1993	TOTAL
BSc (Information Science)	1	4	5
BSc (Computer Science)	1	2	3
Other Universities studies (e.g. Arts, Business Administration).	3	0	3
BSc (Computing)	1	1	2
Bachelor of Information Technology	1	0	1
BBus (Information Systems)	1	0	1
BCom (Information Systems)	1	0	1
TAFE	1	3	4
Total	10	10	20

By excluding graduates with no intention to enrol in further studies, the above table reveals that the others are interested in pursuing Bachelor degrees in the area of computing or a related field.

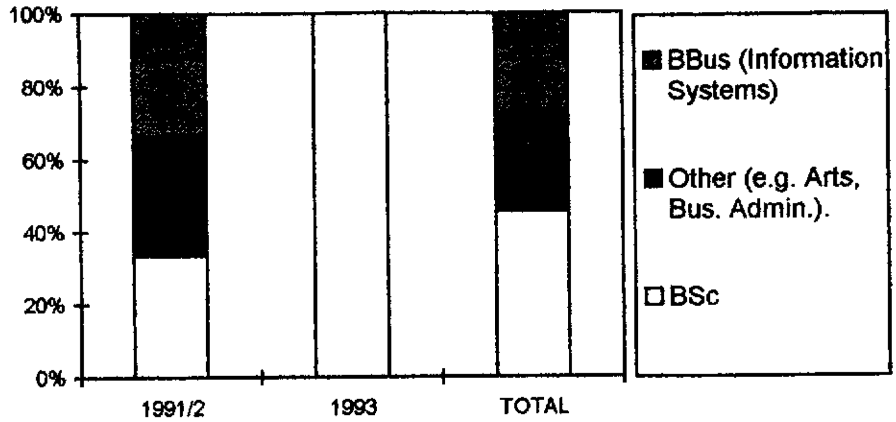


Graduates preferred Computer Science or Information Science over Information Systems degrees. They normally received 8 units as credit towards their university computing degrees or related field.

Types of courses

Group types of courses	1991/2	1993	TOTAL
BSc	3	7	10
Other (e.g. Arts, Bus. Admin.).	3	0	3
BBus (Information Systems)	3	0	3
Total	9	7	16

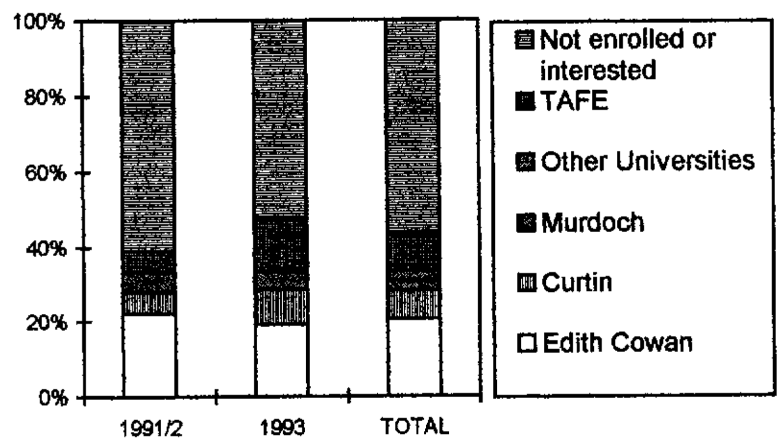
In grouping the types of courses (e.g. Science versus Business courses), the above table shows that graduates preferred a Computer Science more than a Business stream course in Information Sciences.



Probably, graduates preferred to study computer science subjects as the Associate Diploma in Applied Science (Computing) curriculum emphasises more about Computer Science than Information Systems. For example, Business Economics or other similar subjects are not taught in the Associate Diploma course. In addition, the curriculum of the Associate Diploma in Applied Science (Computing) is linked more closely with the Bachelor of Science in Computer Science course than the Bachelor of Business courses in Information Systems in universities.

Question 30.c: Graduates enrolled in or intended to enrol in tertiary institutions to further their qualifications.

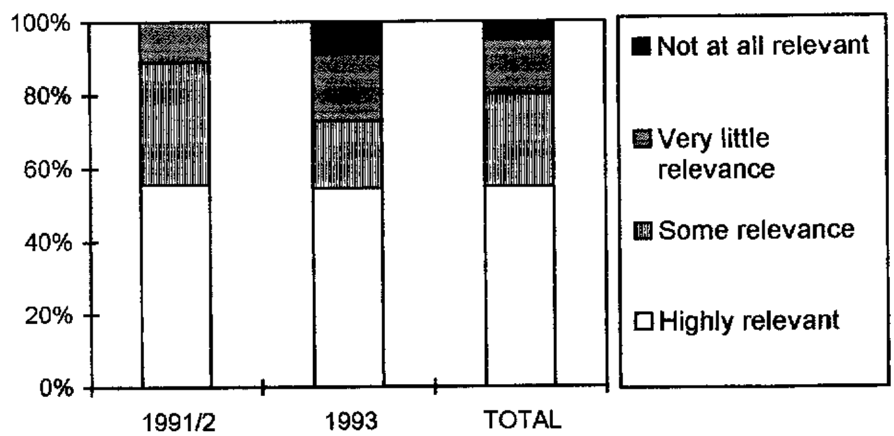
	1991/2	1993	TOTAL
Edith Cowan University	4	4	8
Curtin University	1	2	3
Murdoch University	1	0	1
Other Universities	0	1	1
TAFE	1	3	4
Not enrolled or interested	11	11	22
Total	18	21	39



About 40% of the Associate Diploma in Applied Science (Computing) graduates were enrolled or interested in pursuing further studies at university. This was on the increase by nearly 10% between 1991 and 1993. Cowan University attracted most of the graduates (Around 20%). More than 50% of graduates were not enrolled or interested in further studies when the surveys were conducted in August 1993 and 1994.

Question 31: Relevance of the Associate Diploma in Applied Science (Computing) course to further studies undertaken by graduates.

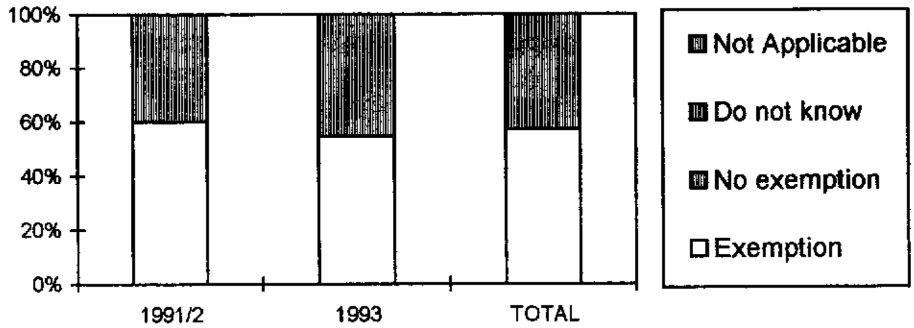
	1991/2	1993	TOTAL
Highly relevant	5	6	11
Some relevance	3	2	5
Very little relevance	1	2	3
Not at all relevant	0	1	1
Total	9	11	20



The Associate Diploma course is very much relevant to what the graduates are learning at university when the highly and relevant ratings were included (80%). But, there was a small decline in the course relevance. This was probably due to the curriculum maintenance policy.

Question 32: Credit received by TAFE graduates towards further studies (Degree or Diploma)

Credits	1991/2	1993	TOTAL
Exemption	6	6	12
No exemption	0	0	0
Do not know	0	0	0
Not Applicable	4	5	9
Total	10	11	21



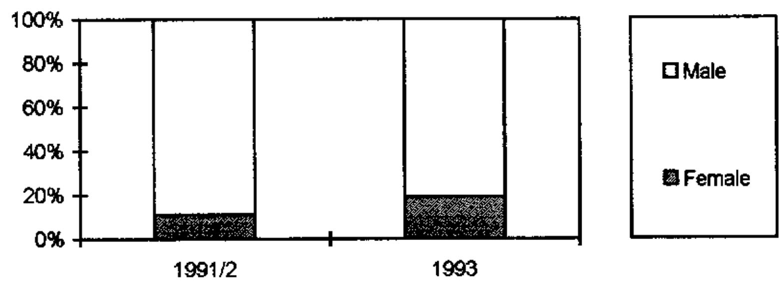
As expected, all of the graduates received credit for their further studies. After discussions with two senior educators from universities, they confirmed that a substantial number of the Associate Diploma in Applied Science (Computing) graduates had enrolled at Edith Cowan or Curtin universities, completing their degree courses in Information System or Computer Science, very successfully. The question of graduates' achievement at universities needs to be further explored.

Section 5: Demographic profile of graduates

This section provides information about the age and gender of the graduates. It also gives an indication on their ethnic background and whether they found jobs in Australia.

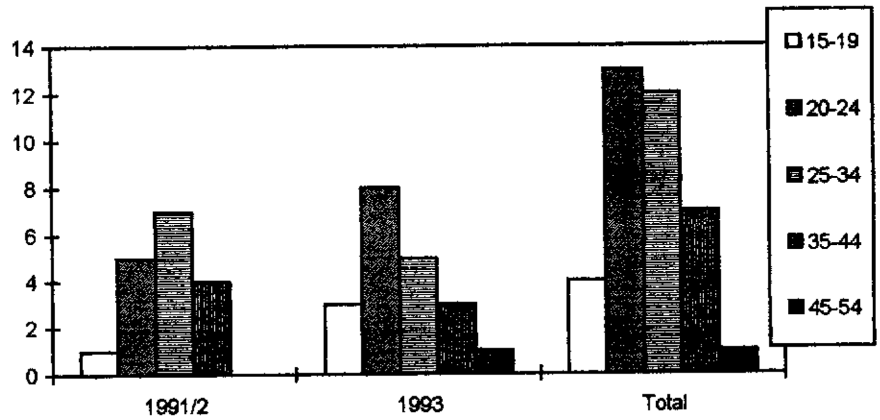
Question 33: Distribution of graduates by gender.

	1991/2	1993	Total
Female	2	4	6
Male	16	17	33
Total	18	21	39



Question 34: Distribution of graduates by age. In this case, the sample size consists of only 37 respondents

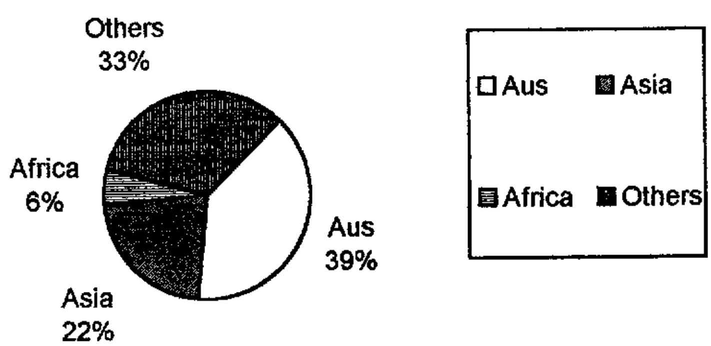
	15-19	20-24	25-34	35-44	45-54	Total
1991/2	1	5	7	4	0	17
1993	3	8	5	3	1	20



The distribution of students' age who graduated, varied from the age of 19 to 45 years old (Part and fulltime). There was an increase in students aged from in the 15 to 19 range.

Question 35: Distribution by country of birth.

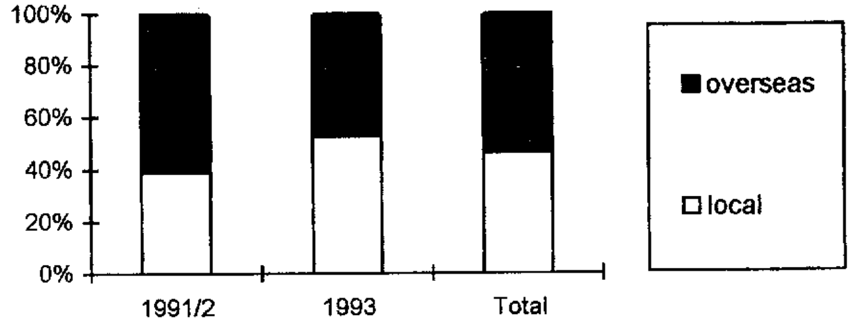
	Australia	Asia	Africa	Others	Total
1991/2	7	4	1	6	18
1993	11	5	1	4	21



The above figure illustrates the diversity of the graduates' cultural background.

Question 36: Local versus overseas students.

	1991/2	1993
local	7	11
overseas	11	10
Total	18	21



The enrolment of overseas students increased by more than 10 % and in 1993 overseas students represented 50% of the total population. This increase was most likely due to the good reputation of the course among overseas students.

4. Summary

This chapter has taken the system approach introduced in Chapter One (Figure 1.2, p. 5) which consists of five group factors corresponding to the five sections which formed the basis of the survey instruments.

There was no significant increase in Year 12 students enrolled in the Associate Diploma course. Overseas students represented 50 % of the total student population in 1993 and were growing in importance. This indicates that the Associate Diploma course had a good reputation among overseas students. Also, the proportion of students with university qualifications before attending this course, had increased by 4% and represented 10% of the total student population in 1993. Most of the students attending this course, expected to obtain a new job, improve their job or gain extra programming skills (70%). There was a small decline in students' perceptions in achieving their expectations. This was due to the fact that the syllabi, software and hardware were not updated on a regular basis.

Teacher effectiveness indicated a high level of satisfaction with the teaching staff. The staff were thought to have an excellent knowledge of the material and were very effective in delivering the course. Particularly high levels of satisfaction with the quality of teaching were demonstrated in terms of knowledge of content of the course, teaching skills and ability to relate to students. Furthermore, students approved classroom activities based on software design tools and programming across the many subjects and disciplines to promote algorithm design and skill transfer. Course organisation also attracted a high level of satisfaction mainly in the content of the course, relevance to job, length of the course or units, and balance between theory and practice. Therefore, the course was structured appropriately and integrated. Graduates found the curriculum relevant to the IT profession which helped them to easily gain jobs. There was a high employment ratio of graduates. On average, 90% of the graduates were successful in obtaining a job related to their computing course within one year of completing their course. In 1993, there was a higher employment ratio than in 1991/2 due to economic factors and an increased demand of skilled people in the computing area. Graduates also reached high industrial positions as software specialists and general managers in the computing field and were satisfied with aspects of their course. This demonstrates that they were able to adapt easily to new and rapid technological changes which had occurred in the 1990's and required implementation (e.g. various types of relational database and communications systems).

Large private and government organisations employed more than 40% of the computing graduates. Furthermore, graduates attached a great importance to the articulation and accreditation systems with other tertiary institutions. Nearly 50% of the graduates enrolled, or intended to, further studies at TAFE or universities. (30%). Most of the graduates (90%) furthering their studies, had found their course relevant and received credit towards further studies. Finally, the syllabi must be maintained on a regularly basis to include up to date software and hardware which had an impact on graduates' satisfaction with the course. All the above requirements are important factors which must be included in planning and developing a curriculum.

The next chapter contains an evaluation of the satisfaction levels of students who attended the new Certificate IV of the National IT Curriculum, during the first semester 1995. This course used for the first time a Competency Based approach. Like this chapter, it examines students' degree of satisfaction in terms of secondary school and university articulation, teaching effectiveness, course organisation and methods of delivery, curriculum relevance in relation to industry needs, students' employment potential and quality of this new computing programmes.

CHAPTER 5

THE NATIONAL COMPUTING AND INFORMATION TECHNOLOGY (IT) CURRICULUM MODEL: SATISFACTION LEVELS OF STUDENTS ATTENDING THE CERTIFICATE IV OF THE IT NATIONAL CURRICULUM (CBT)

1. Introduction

TAFE representatives from all States, DEET, ACTRAC, the Information Industries Education and Training foundation (IIET)and the Australian Computer Society developed the National Curriculum in response to current and future needs of the Information Technology (IT) industry. To meet National representation that satisfied both industry and educational requirements for IT training, several committee groups (NSW TAFE, 1992/93) were formed to develop a National Curriculum based on the following CBT principles:

- Modular curriculum - Short modules must be developed (e.g. 20 hours). This approach allows modules to be replaced easily with new modules as required.

- Minimal prerequisites - The specification of prerequisite modules is kept to a minimum to provide multiple entry and exit and to make learning as flexible as possible. All prerequisites are in modular form.

- Generic module structure - Modules are as generic as possible and not product or computing language specific.

At the beginning of 1995, course 9614 started to offer the first year of the Diploma of Information Technology (IT) award which is based on the National Curriculum model. Students who complete the first year of the course, are awarded Certificate IV in IT. This is a uniform and standard course across Australia which promotes the idea based on pre-specified and observable skills only as in Competency Based Training (CBT). The proponents of the CBT model emphasise solely job related activities. They claim that this model is more responsive to industrial and technological changes than the first model.

The purpose of this chapter is to analyse, evaluate and discuss the satisfaction levels of students who attended this Certificate IV course, during the first semester 1995. The course used for the first time the Competency Based approach.

This new national course is based on a document which consists of list of learning outcomes that students need to achieve under specific conditions. A sample of a CBT module is included in Appendix B.

As in the previous chapter, this chapter examines students' degree of satisfaction in terms of secondary school and university articulation, teaching effectiveness, course organisation and methods of delivery, curriculum relevance in relation to industry needs, students' employment potential, and quality of this new computing programme.

Finally, this chapter includes the results of the two surveys covered in the previous chapter in order to pay particular attention to changing patterns and trends. These group factors relate to graduates' educational background, satisfaction with aspects of their courses, employment status and further studies who attended the Associate Diploma in Applied Science (Computing). Changes in the pattern of group factors which may have occurred abruptly, temporarily or remained the same between the two curriculum models, provide additional guidelines about the choice of the appropriate curriculum model. Furthermore, the causes of changes in students' satisfaction which occurred by moving from content driven to a CBT driven curriculum are analysed, interpreted and discussed in the light of the literature review and research findings introduced in Chapters Two and Three.

2. The Survey

2.1 Instrument

The evaluation of the CBT based course is based on a simplified questionnaire used by the 1993 National Centre of Vocational Educational Research (NCVER) to survey graduates' satisfaction and destination. The questionnaire designed initially by NCVER was revised, but kept similar to the NCVER graduates' questionnaire conducted in 1991, 1992 & 1993 to enable meaningful comparisons. The instrument, consisting of closed questions, was organised into four sections and based on the CBT research questions emanating from Chapter One (Figure 1.2, p. 2). Question 12 provides students with the opportunity to make comments about aspects of their CBT course. The number of questions was reduced to a minimum. Responses to each question are discussed and evaluated in this chapter. The relevant information was extracted, vetted for coding errors, compiled and cross checked for reasonableness checks by discussing with all the students their responses, comments or suggestions for clarification. A sample questionnaire is included in Appendix D.

2.2 Sample size and techniques used

The survey was conducted during the last week of June 1995. The same five teachers involved in the Associate Diploma course, taught in this course. The sample size consists of 33 fulltime and 8 part-time CBT students who completed their first semester of the Advanced Certificate IV of the IT National Curriculum, during the 1995 academic year. The reliability level of responses could have been enhanced by further survey samples from semester 2 or student intake in 1996, but the time frame prevented any such input into this study.

The percentage may not always add up to 100% as some respondents chose not to reply to some questions. Questions which required a qualitative answer also have been included in this study (e.g. student suggestions to improve the syllabus).

3. Analysis of the questionnaire, discussion and evaluation

The following four sections which correspond with the four sections of the questionnaire. The survey consisted of the following 4 sections:

- Section 1: Educational background of the graduates before enrolling in a TAFE course (e.g. entry level);
- Section 2: Graduates' satisfaction with their course (e.g. course organisation);
- Section 3: Employment status of the graduates (e.g. ability of graduates to get a job related to their studies); and
- Section 4: Further studies (e.g. students' preferences).

After completing the questionnaire, students were interviewed to find out whether there were any contradictions between their answers and their comments or suggestions about their studies.

Section 1: Educational background of the students before enrolling in the Certificate IV of the National Curriculum

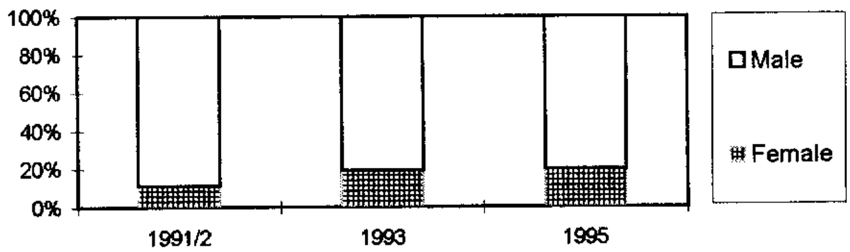
This section of the questionnaire deals with the entry level of the graduates before they attended the Certificate IV if the National IT Curriculum course (1995).

Question 1a: Forty one students were surveyed consisting of 33 fulltime and 8 part-time students who attended the first semester CBT course in 1995 (Certificate IV).

For comparison purpose, 39 graduates who attended the content driven curriculum (Associate Diploma in Applied Science-Computing) in 1991/2/3, are included in this evaluation.

Question 1b: Distribution of graduates by gender:

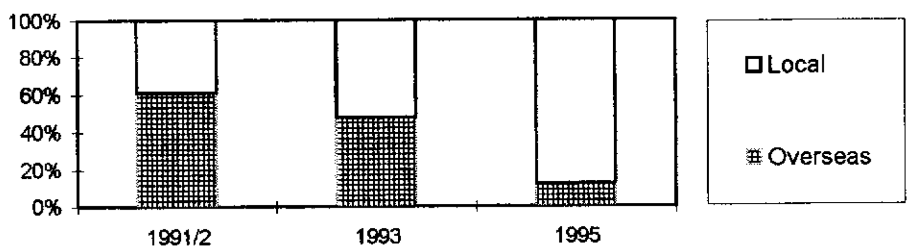
	1991/2	1993	1995	Total
Female	2	4	8	14
Male	16	17	33	66
Total	18	21	41	80



The proportion of female to male students increased.

Question 1c: Local versus overseas students.

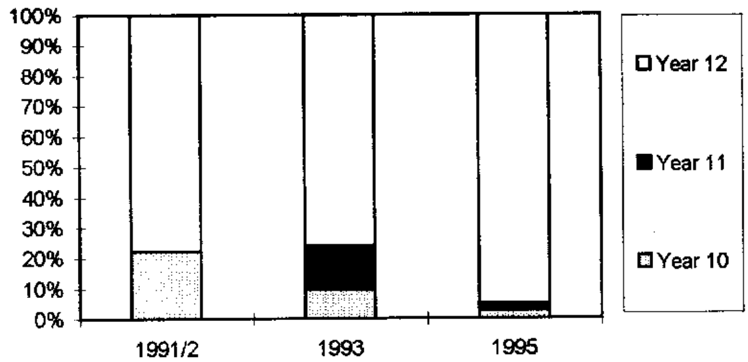
	1991/2	1993	1995
local	7	11	36
overseas	11	10	5
Total	18	21	41



Enrolment of overseas students decreased significantly and consisted of only 12 % of the total student population in 1995. This decrease is related to a decline of perceived standards perhaps due to the introduction of CBT. The reason for this conclusion is that after further investigation based on interviews of overseas students, it was found that they preferred to enrol in the Associate Diploma in Applied Science (Computing) which had ceased to take new students. At the beginning of the 1995 academic year, they enrolled in the Certificate IV of the National IT Curriculum course. But, later, most of them withdrew from the course to join a private college which offered a subsidised and similar course to the Associate Diploma of Applied Science (Computing).

Question 2: The highest level completed at school before the students attended the Associate Diploma in Applied Science (Computing) or the Certificate IV (IT) of the National IT Curriculum during the first semester 1995.

Highest level completed	Year 10	Year 11	Year 12	Total
1991/2	4	0	14	18
1993	2	3	16	21
1995	1	1	39	41
Total	7	4	69	80

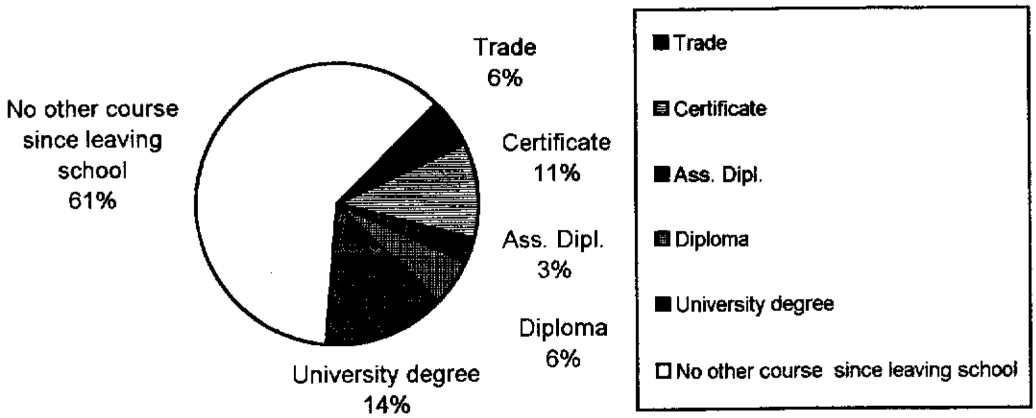


More than two third of the students had completed their secondary schooling. There was no increase in Year 12 graduates between 1991 and 1993. But, there was an increase of year 11 intake. There was a significant increase in Year 12 students enrolled in the Certificate IV of the National IT Curriculum.

Question 3: Highest qualification obtained before the graduates attended the Associate Diploma in Applied Science (Computing) or the Certificate IV (IT) courses.

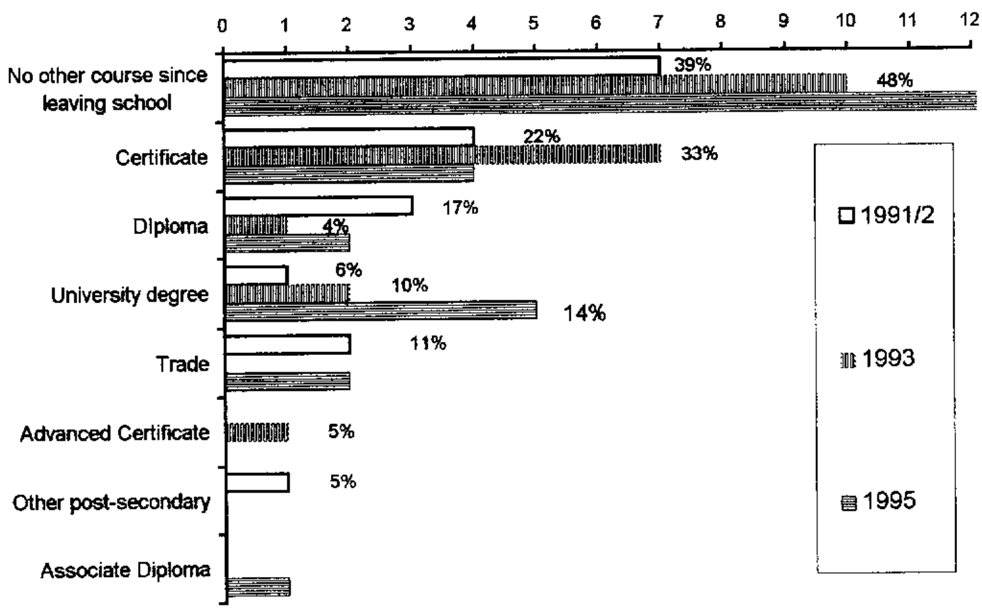
Highest qualification on entry	1995
Trade	2
Certificate	4
Associate Diploma	1
Diploma	2
University degree	5
No other course since leaving school	22
Total	36

The above table relates to the entry level of Certificate IV students attending their CBT course.



The above figure shows that 14% of students in 1995 had university qualifications before they started their CBT course.

Trends on highest qualification on entry	1991/2	1993	1995	Total
Trade	2	0	2	2
Certificate	4	7	4	15
Advanced Certificate	0	1	0	1
Associate Diploma	3	1	1	5
University degree	1	2	5	8
Other post-secondary	1	0	0	1
No other course since leaving school	7	10	22	39
Total	18	21	36	75



The above table and figure show trends of the types of qualification of students before attending their courses from 1991 to 1995. The comparison is based on the NCVER, Arrowsmith (1994 &1994), Dawe (1993) reports, and the recent CBT survey conducted in 1995. The above figure clearly revealed that CBT students with university qualifications are on the increasing in the Certificate IV in IT and 14% of students in 1995 had university qualifications before they started this course. The pattern of the educational background of the graduates and students enrolled in the content curriculum remained more or less the same. However, students enrolled in the National IT Curriculum who had completed their secondary schooling increased (77% to 96%).

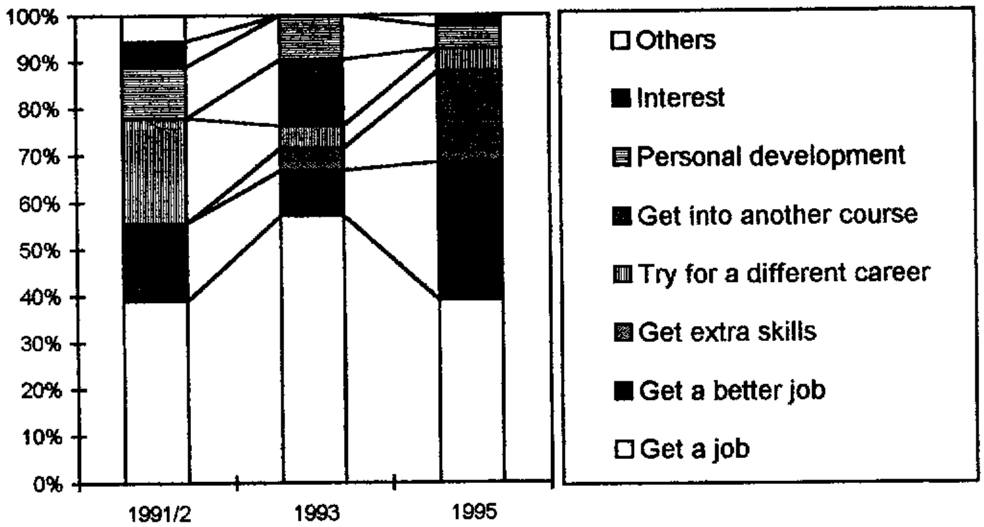
Section 2: Students' satisfaction with their CBT course

The method of delivery of the two contrasting curricula was based on face-to-face teaching and practical exercises on computer terminals. The five teachers were asked not to change the way they taught in order to facilitate the comparison between the two curriculum models. This section on satisfaction of the graduates and students covers factors related to teacher effectiveness and course organisation.

Question 4 a: The most important reasons for undertaking this course

Reasons for undertaking this course	1991/2	1993	1995	Total
Get a job	7	12	16	35
Get a better job	3	2	12	17
Get extra skills	0	1	8	9
Try for a different career	4	1	2	7
Get into another course	0	3	0	3
Personal development	2	2	2	6
Interest	1	0	1	2
It was a requirement for the job	0	0	0	0
Others	1	0	0	1
Total	18	21	41	80

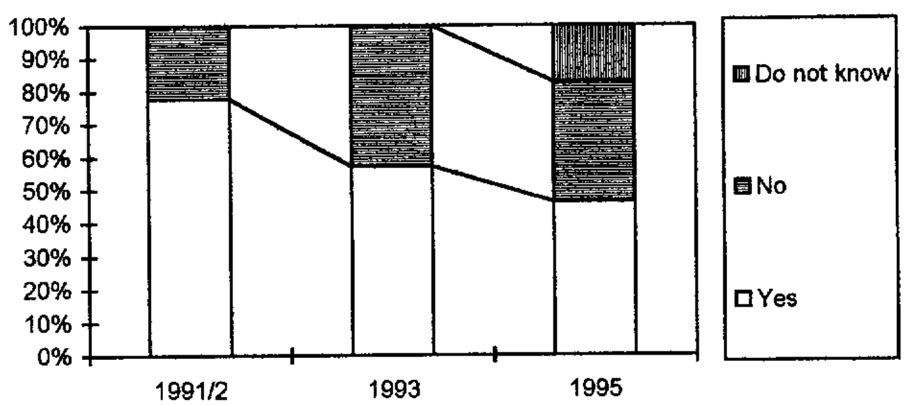
To get a job, a better job or gain extra skills are the most important reason for students to attend TAFE courses. It is noteworthy that none of the part-time respondents were required by their employers to attend these courses.



Most of the CBT students and graduates attended their courses for reasons related to obtaining a new job, improving their job, or gaining extra skills in the areas of computing (80%).

Question 4b (12): The course helped to achieve the above objectives stated in the previous question.
Note: The Q12 refers to the NCVER questionnaires.

Courses met the objectives	1991/2	1993	1995	Total
Yes	14	12	19	45
No	4	9	15	28
Do not know	0	0	7	7
Total	18	21	41	80



Between 1991/2 and 1993, there was a noticeable decrease in students' perceptions in meeting their main objective in undertaking the course (Job related course). This may be due to the fact that the syllabi, software and hardware equipment were not updated on a regular basis to meet industry needs. For example, there was no systematic update of the syllabi from Head Office since 1989.

In 1995, most of the fulltime CBT students stated that they did not yet have a job. But, their perceptions were divided on whether the course had met their main objective. After further interviews, they were not all convinced that the course would help them obtain a job. This question is analysed further in discussing Question 12 in relation to comments they made about aspects of their CBT course.

Question 5 (13): The method of delivery for this course

As expected, all Associate Diploma graduates mentioned face-to-face teaching and Computer Aided Instructions (e.g. computer programming and use of CASE tools) as a method of delivery. However, computer programming activities declined substantially in importance with the introduction of CBT in 1995 (Chapter 3, Figure 3.4, p.46). None of the CBT students had mentioned C.A.I as a method of instruction.

Question 7 (18): Satisfaction with teaching staff and the course.

This question is subdivided into 13 sub-questions as below.

The following sub-questions are related to teacher effectiveness:

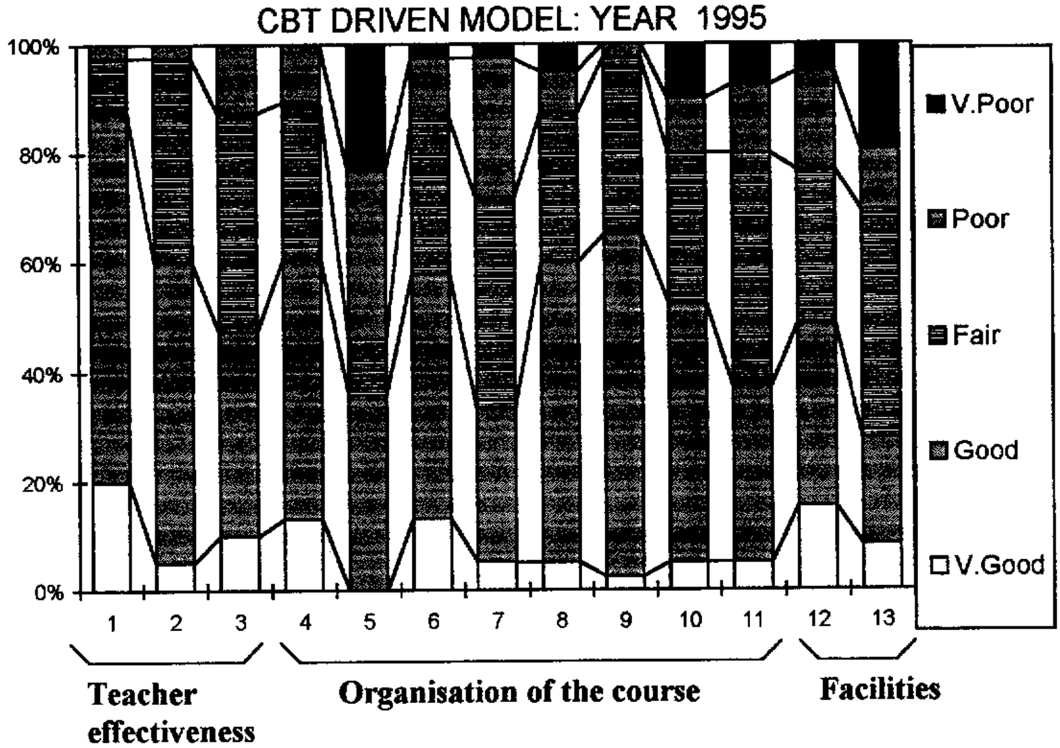
1. Knowledge of content of this course
2. Teaching skills for this course
3. Ability to relate to students

The following sub-questions are related to course organisation and facilities:

4. Content relevant to job
5. Length of the course
6. Balance between theory and practice
7. Availability of options
8. Time and Day classes offered
9. Amount of contact with teacher
10. Printed materials and lesson notes
11. Assessment method
12. Equipment for practical skills
13. Library or learning resources

Levels	1	2	3	4	5	6	7	8	9	10	11	12	13
V.Good	8	2	4	5	0	5	2	2	1	2	2	6	3
Good	27	22	15	18	14	17	11	22	25	19	13	13	7
Fair	4	15	16	11	4	11	15	11	13	11	17	11	15
Poor	1	1	5	4	12	4	10	3	1	4	5	7	4
V.Poor	0	0	0	0	9	1	1	2	0	4	3	2	7

The above table reveals the satisfaction levels of CBT students about teacher effectiveness, course organisation and facilities during the first semester, 1995.

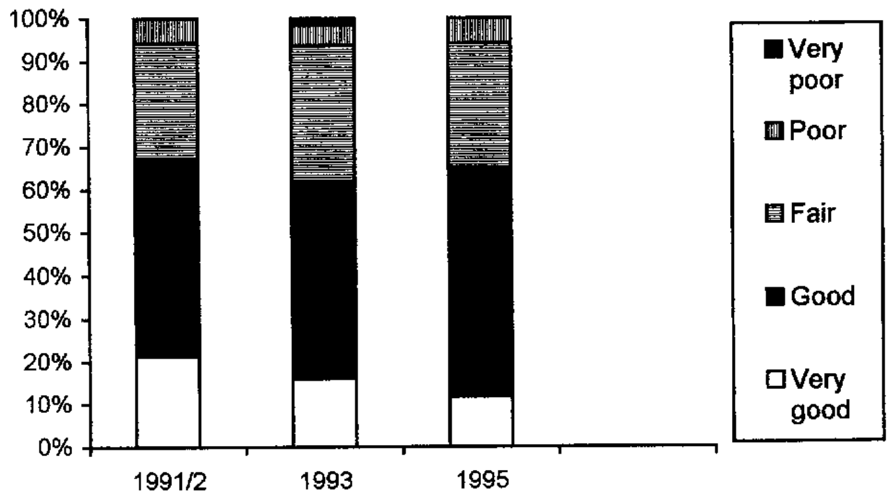


Students attending the Certificate IV (IT) course demonstrated high levels of satisfaction (Above 90%, if very good, good and fair ratings are included) with most aspects of their computing course. Particularly high levels of satisfaction were demonstrated with the quality of computing teachers in the following aspects of the course: knowledge of the content (1); teaching skills (2); and ability to relate to students (3). Another area to attract a high level of approval was the amount of contact with teachers (9). Class sizes did not affect students perception of learning, but after further interviews with students, they revealed that they prefer small programming classes. Availability of options (7) remained unchanged because of limited resources. Time and day classes (8) attracted 90 % of satisfaction.

It is noteworthy that module length (5) increased significantly and represented 55% of the students' dissatisfaction. The very dissatisfied students went up by more than 20%. The availability of options (7) and assessment method (11) also demonstrated lower levels of satisfaction. The equipment used for practical skills (12) and the availability of learning resources (13) to complete assignments and projects had high levels of dissatisfaction. 20% of students were very dissatisfied.

This question of students' satisfaction with their teachers and course organisation of the Associate Diploma (Computing) was introduced in the fourth chapter.

Trends of overall teacher effectiveness	1991/2	1993	1995
Very good	11	10	14
Good	24	29	64
Fair	14	20	35
Poor	3	3	7
Very poor	0	1	0
Total	54	63	120



The above figure depicts the overall teacher effectiveness from 1991 to 1995. It shows a very high satisfaction with teachers from 1991/92 to 1995. 70% of the students were very satisfied or satisfied with the overall computing course, but there was a slight decrease in the highly satisfied graduates between 1991 and 1995. Students attending the Certificate IV of the National IT Curriculum demonstrated high levels of satisfaction (Above 90%, if fair rating is included) with most aspects of their computing course. Particularly high levels of satisfaction with the quality of computing teachers were demonstrated in the following aspects of the course as indicated in responses to the following sub-questions: knowledge of the content (1); teaching skills for this course (2); and ability to relate to students (3).

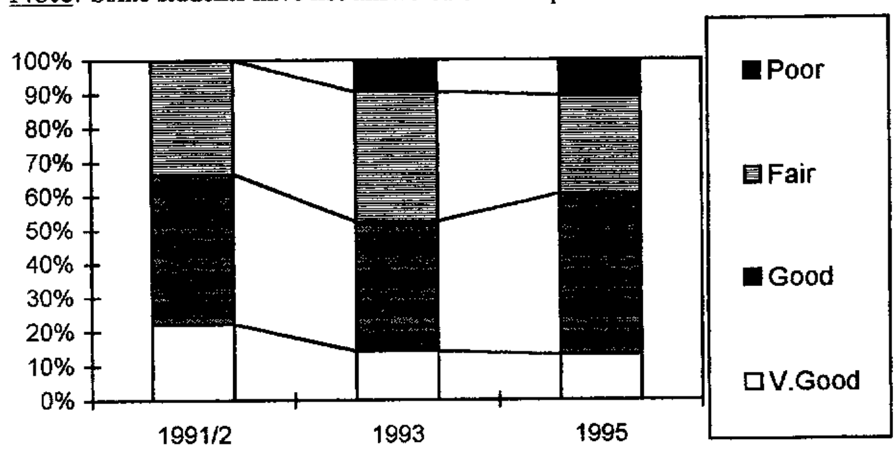
The following section relates to course organisation. It compares whether there were pattern changes in students' satisfaction in terms of content relevant to job (4), length of the course or modules (5) and balance between theory and practice (6).

* Content relevant to job (4)

Most of the content of the syllabi and CBT courses are dependent on the software and hardware platforms used in the College. This question reveals that the following changes had occurred:

Content relevant to job (4)	1991/2	1993	1995
Very Good	4	3	5
Good	8	8	18
Fair	6	8	11
Poor	0	2	4
Very Poor	0	0	0
Total	18	21	38

Note: Some students have not answered certain questions.



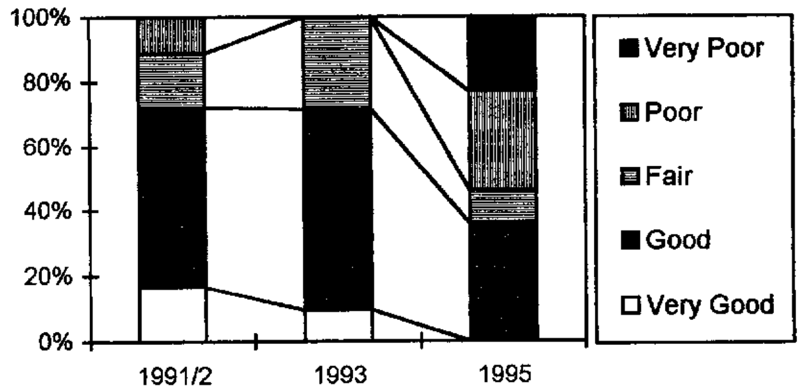
In 1991/2, relevance of the content to employment attracted high satisfaction levels (including very good, good and fair ratings). However, there was a decrease of very satisfied students by 5%, corresponding to an increase in dissatisfied students by 10%. The overall satisfaction levels decreased by about 10% in 1991/2. Further investigation revealed that this decline was probably due to the lack of consistent syllabi, software and hardware maintenance policies. Between 1993 and 1995 the satisfaction level remained constant as there were few changes in software and hardware, but with a slight increase in satisfied CBT students. This may be due to the fact that fulltime students were not fully aware of the relevance of the course content to job. They had just completed one semester. But, after further investigation, four part-time CBT students revealed that the content was not very relevant to their computing work.

* Length of the course or modules (5)

In the syllabus, the length relates to a semester unit (60 hours) or subject. In CBT, a module consists of twenty contact hours.

Length of unit or module (5)	1991/2	1993	1995
Very Good	3	2	0
Good	10	13	14
Fair	3	6	4
Poor	2	0	12
Very Poor	0	0	9
Total	18	21	39

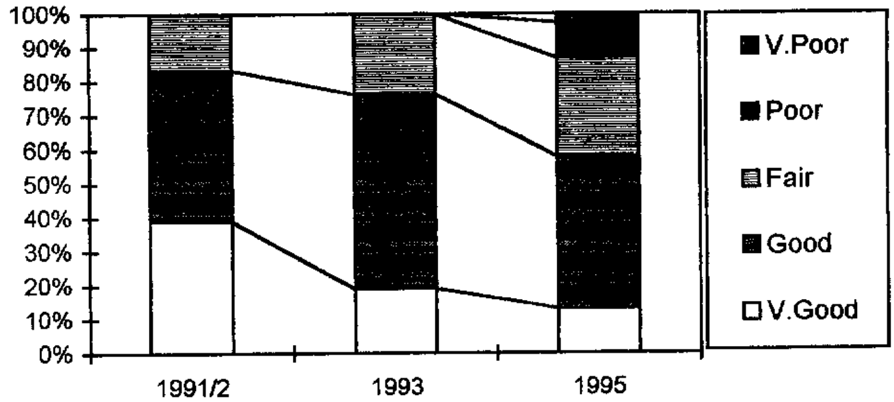
The above table reveals changes that had occurred in satisfaction levels by modifying the length of the course or modules.



In 1991/2 and 1993, the length of the content driven course attracted high levels of satisfaction (more than 70%, including very good and good). This was discussed in Chapter Four. However, there was a decrease from 70% in 1993 to 40% in 1995. This decline coincided with the introduction of the CBT modular approach. This question is discussed further in Question 9 and 12 where students' comments were collected and discussed. The length of each CBT module (5) represented 55% of the students' dissatisfaction (p. 101), but also the availability of options (7) and assessment method (11) demonstrated lower levels of satisfaction.

- Balance between theory and practical (6). Practice refers to design using CASE tools and programming activities on the computer terminal.

Balance between theory and practice (6)	1991/2	1993	1995
Very Good	7	4	5
Good	8	12	17
Fair	3	5	11
Poor	0	0	4
Very Poor	0	0	1
Total	18	21	39



Under the content driven model between 1991/2 and 1993, the balance between theory and programming attracted high levels of satisfaction (including very good and good). But, there was a gradual decrease from more than 85% to 75% due to minor changes in the course mix. There was a marginal increase in computer theory at the expense of computer programming work. This was discussed in the Chapter Three (Figure 3.4 & 3.6, pp. 46-47). Further investigation, revealed that limited software and hardware resources were allocated to the IT study area for computer design using CASE tools and programming activities. In addition, discussions with past graduates had revealed high satisfaction with the course structure and profile of the Associate Diploma (Computing).

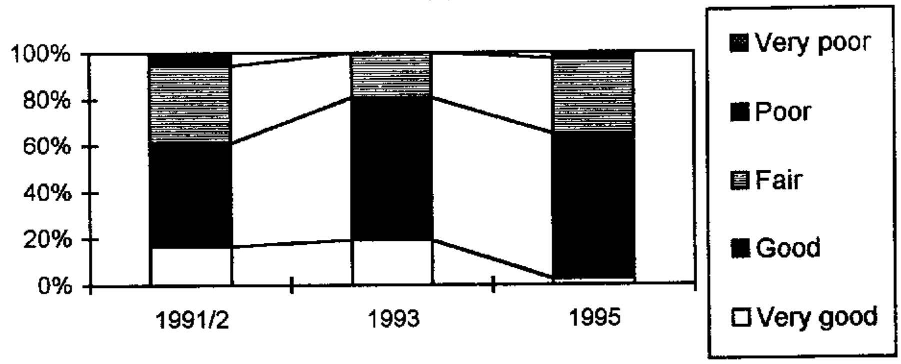
With the introduction of CBT, there was a further decrease to 60% of the very satisfied and satisfied students. In addition, further investigation revealed an increase of 15% of students' dissatisfaction levels if very poor and poor answers are included. This increase in disapproval was due to changes in the CBT course mix. Non-computing modules such as technical writing and system and programming documentation, and computer theory played a major role at the expense of computer development (CASE tools) and programming activities. This was discussed in Chapter Three (p. 47). Further investigation, had also revealed that limited software and hardware facilities were available to the IT study area for programming activities. This CBT course profile is discussed further in Question 9 and 12 of this chapter where students' comments and interviews were analysed and evaluated.

The following section investigates in more detail whether patterns changes occurred in the course organisation. This includes the following sub-questions 7 to11.

- Availability of options, time and day classes and class sizes (7 & 8)

Under the both models between 1991 and 1995, availability of options declined gradually due to limited resources and time tabling difficulties. In interviews with past and present students, it appears that class size did not affect students' perception of learning in both courses. But, they stated that they prefer small CASE tools and programming classes.

* Amount of contact with teachers (9)

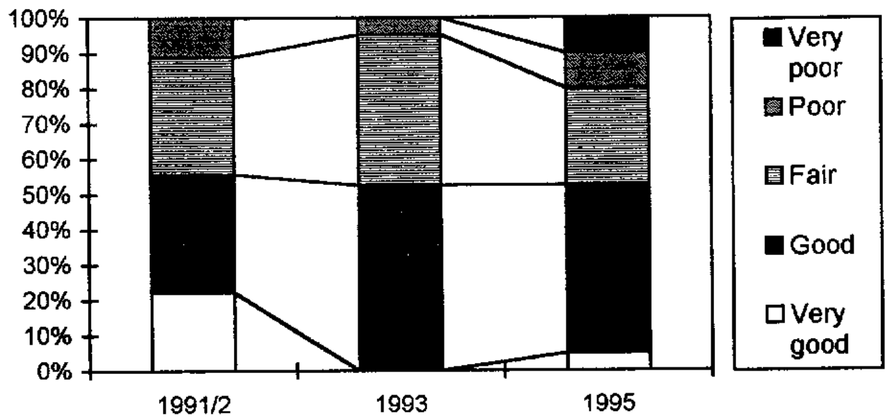


With the introduction of CBT in 1995, students' satisfaction level declined by more than 15% due to the modular approach and a consequent undesirable time table for students.

The amount of contact with teachers (9), lesson notes (10) and assessment (11) attracted high satisfaction levels if very good, good and fair answers are included.

* Instructional material and lesson notes (10)

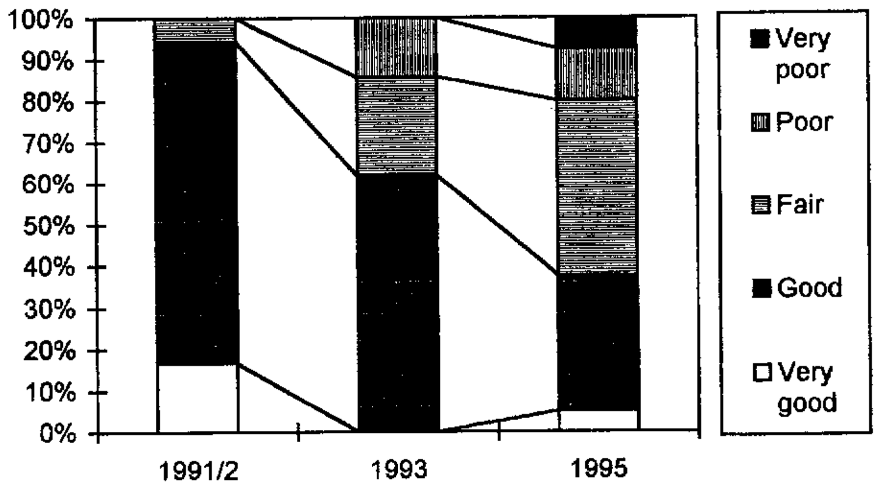
Instructional material and lesson notes (10)	1991/2	1993	1995
Very good	4	0	2
Good	6	11	19
Fair	6	9	11
Poor	2	1	4
Very poor	0	0	4
Total	18	21	40



The percentage of dissatisfied students increased probably because non-computing and other computer CBT modules were introduced at short notice and there was limited instructional material (e.g. Gathering information module). Also, in interviews with CBT students, the question of module overloading, where too many or too few learning activities are packed into a module, was raised. This question is discussed later in this chapter.

- Assessment method (11)

Assessment methods (11)	1991/2	1993	1995
Very good	3	0	2
Good	14	13	13
Fair	1	5	17
Poor	0	3	5
Very poor	0	0	3
Total	18	21	40



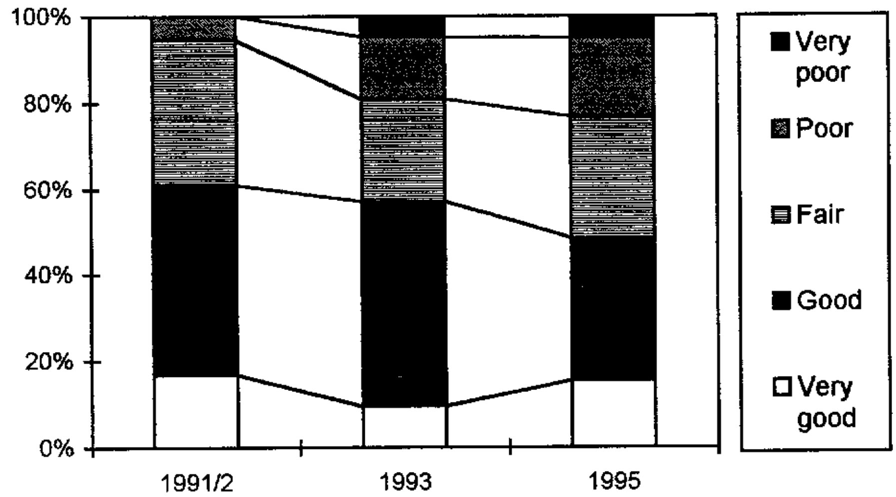
Students' dissatisfaction increased gradually between 1991/2 and 1994 when the ratio of internal assessment to external examination changed from 40/60 to 30/70 in the Associate Diploma of Applied Science (Computing) programme. The questions of examination and grading in the CBT system are discussed further in this chapter (p. 109 and p.118), when students had the opportunity to comment about their CBT course.

The next group of sub-questions are related to learning facilities and the following two sub-questions:

12. Computer equipment for practical skills
13. Library or learning resources

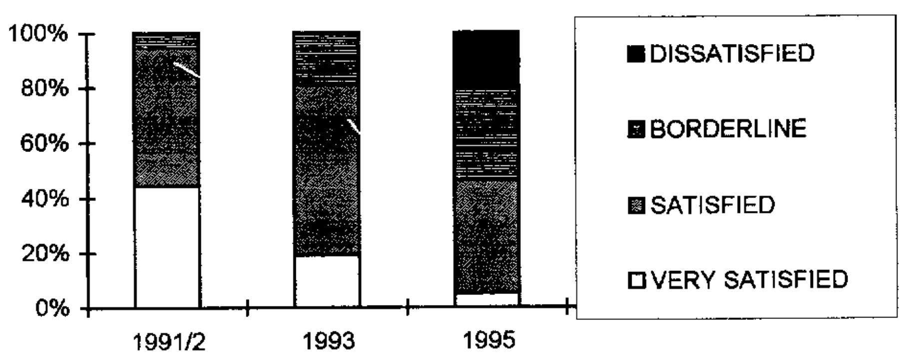
- Only computer equipment for practical skills (12) is of interest and, it refers to the availability of computer software and hardware for programming facilities.

Satisfaction with computer equipment (12)	1991/2	1993	1995
Very good	3	2	6
Good	8	10	13
Fair	6	5	11
Poor	1	3	7
Very poor	0	1	2
Total	18	21	39



There was a gradual decline in very satisfied and satisfied students between 1991/2 and 1993. But, between 1993 and 1995, there was little change in the level of services for practical work. The low level of satisfaction was due to poor maintenance services. The computer equipment used for practical skills (12) and the availability of learning resources (13) to complete assignments and projects had high levels of dissatisfaction (nearly 25 %).

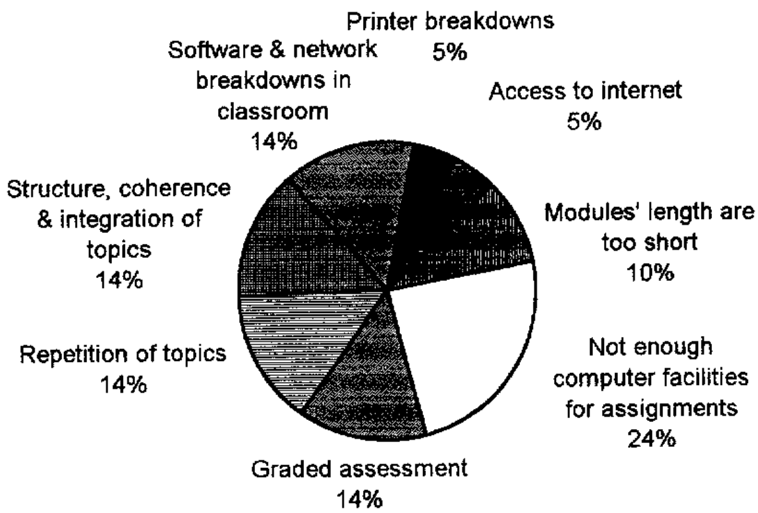
Question 8: Overall satisfaction.



The previous figure depicts trends in students' overall satisfaction with aspects of their courses. The levels of satisfaction of graduates in 1991/2, are significantly higher than those for the CBT students in 1995. Also, there was an increase of 20 % of CBT students' overall dissatisfaction with aspects of their course for the reasons discussed in the next question and question 12 (p. 118).

Question 9: Students' suggestions to improve instructional activities or services

In Chapter 4, there were no comments available from graduates when NCVER, Arrowsmith (1993 & 1994) and Dawe (1993), conducted its surveys about Associate Diploma graduates' satisfaction and their destination. The following students' suggestions were only related to the CBT Certificate IV course.



The above figure illustrates that 52% of students were dissatisfied with the course organisation for the following reasons:

- Structure, coherence and integration of topics (14%);
- Duplication of topics (14%);
- Assessment method (e.g. No grading, 14%);
- Module length too short (e.g. twenty hours per module) and not in-depth study (10%); and
- More resources allocated to provide them with adequate computer facilities to complete their assignments (24%).

In excluding problems related to computer services, the above figure shows that most of the course organisation caused students' dissatisfaction with aspects of their CBT course in 1995 and represents 52% of students' total concern.

Section 3: Employment status

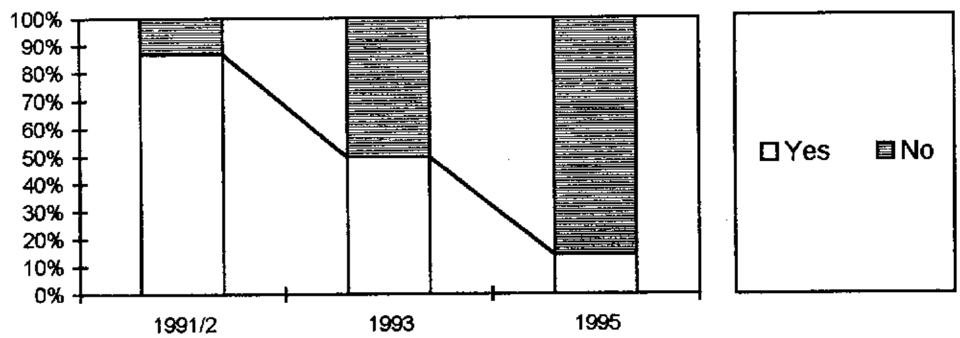
This section deals with the employment questions of students. It deals with the facility of students to gain jobs related to their course. This section of the questionnaire is important because it indicates whether the course enabled students (fulltime or part-time) to easily obtain a job related to the course.

Question 10a (Q 24.1): Students had a job related to their course before they commenced the course.

Note: Q 24.1 refers to the question number of the NCVER and WADOT questionnaires introduced in the previous chapter.

CBT students who had a job related to their course, were part-time students. One student changed from fulltime to part-time course in the second semester.

Job related to the course	1991/2	1993	1995
Yes	13	7	5
No	2	7	30
Total	15	14	35



The above figure illustrates that 90% (1991/92) and 50% (1993) of working graduates were employed in jobs related to their Associate Diploma in Applied Science (Computing) before they commenced the course. In comparing 1991/2 and 1993, there was a percentage decrease in working graduates, having obtained jobs related to their course. One assumption may be that students may have find more difficulty in obtaining relevant jobs in a very competitive and stagnant IT market during 1993. The other assumption may be related to employers' preferences to employ only graduates in a very competitive market.

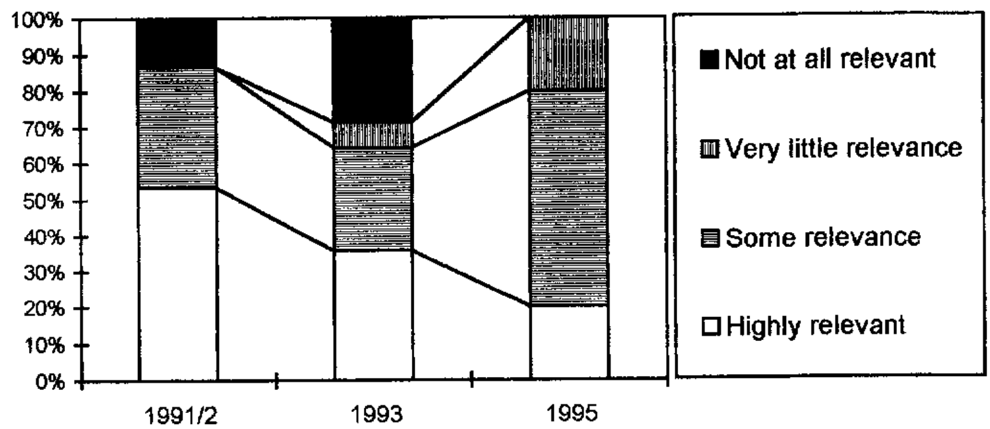
In 1995, five CBT students who had a job related to their course, were part-time students. One student changed from fulltime to the part-time course in the second semester to start work related to his course and, after further investigation, he stated that the CBT course played a part in gaining a job. It is also noteworthy that there was a further decrease by 15% of CBT students who had a job before starting this course.

Question 10b (24.2): The course played a part in gaining a job.

Calculation of the employment ratio introduced in the Chapter Four (p. 79), shows that 90% of all graduates had a job related to their Associate Diploma in Applied Science (Computing). One CBT part-time student stated that the course played some part in his gaining a job in the first semester 1995. But, five CBT students revealed that the course did not play any part in them gaining a job related to the course.

Question 10c (27): Relevance of the course to the job listed above.

Relevance of the course to job	Highly relevant	Some relevance	Very little relevance	Not at all relevant
1991/2	8	5	0	2
1993	5	4	1	4
1995	1	3	1	0



The above table and figure illustrate a decrease in the course relevance to jobs perceived by 1991/92 and 1993 graduates of the Associate Diploma (Computing). Over the two years, the course was highly relevant or had some relevance (75%) to the jobs that the graduates performed. There is a noticeable decline in course relevance from 1991/92 to 1995. This decrease may be due to the lack of maintenance policies of the syllabi since 1989. After further investigation, it was found that the software and hardware were not updated continually to match the technological changes occurring in the IT industry.

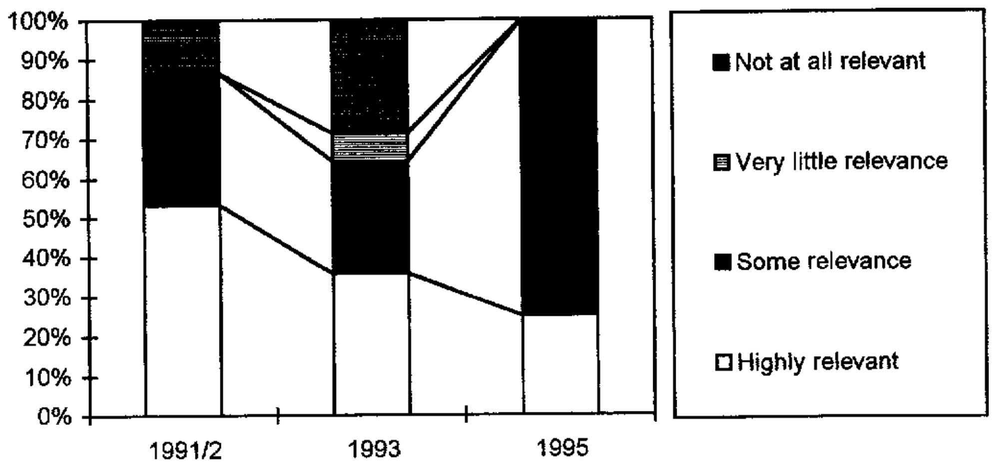
In 1995, five part-time CBT students attending the Certificate IV of the National IT Curriculum had a job related to their course. However, they expressed their concerns at having to use old versions of the software/hardware and faced additional problems in completing their assignments and projects.

Question 10d: Students had a job in IT before starting this course.

This question was not asked to the Associate Diploma (Computing) graduates. Five part-time students of the Certificate IV (1995), worked in IT before starting this course.

Question 10e (27): Relevance of what students learned.

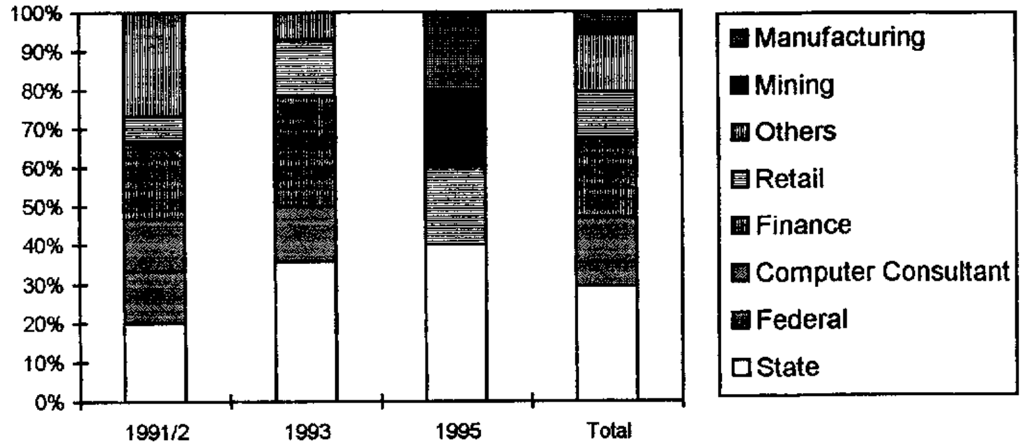
	Highly relevant	Some relevance	Very little relevance	Not at all relevant
1991/2	8	5	0	2
1993	5	4	1	4
1995	1	3	0	0



Most of the graduates between 1991 and 1993 found the Associate Diploma (Computing) course relevant to their job. The 1995 sample size relates to four part-time students who attended the Certificate IV of the National IT Curriculum. All found their course somewhat relevant to their job but they would have preferred to study Oracle instead of MS/Access database software. Oracle was not offered because of limited access to the VAX computer and the software package. This question is further discussed in questions 10f and 12 where students raised some further issues about the CBT course.

Question 10 f (28.a): Students and graduates employment by industry types.

	State/ Local	Federal	Computer Consultant	Finance	Retail	Other	Mining	Manu-facturing
1991/2	3	2	2	3	1	4	0	
1993	5	0	2	4	2	1	0	
1995	2	0	0	0	1	0	1	1
Total	10	2	4	7	4	5	1	1

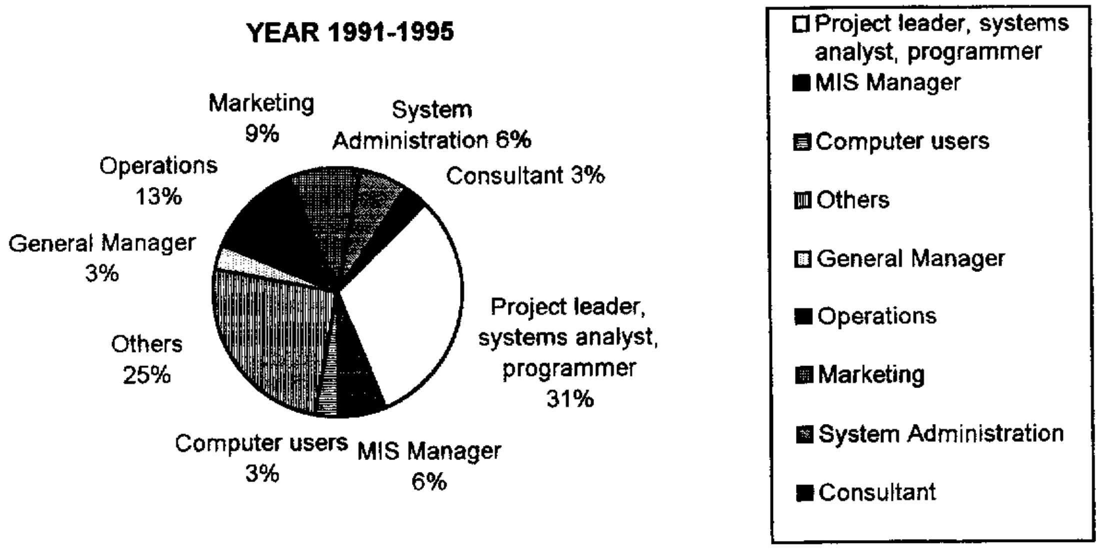


Overall, more than one third of the 1991/2 and 1993 graduates and CBT part-time students surveyed worked for the State or Federal government. One third of part-time students attending the Certificate IV (National Curriculum) worked for government agencies which indicates that future occupational surveys need to consider government requirements and trends in computer software/hardware. Students' opinions need also to be taken into account if curriculum and course changes are made. For example, two part-time students attending the CBT course felt that the CBT database course was emphasising personal computer activities (e.g. Microsoft Access) at the expense of more relevant database software such as Oracle.

Question 10g (28b): Occupation or job title of graduates.

	a	b	Users' support	Others	c	d	Sales	System administration	Computer Consultant
1991/2	4	2	1	4	1	3	0	0	0
1993	6	0	0	4	0	1	3	0	0
1995	0	0	1	1	0	0	0	2	1
Total	10	2	2	9	1	4	3	0	1

Note: Column (a) relates to the following job titles: Project leader, systems analyst, systems and application programmer. Column (b) is related to the position of MIS manager. Column (c) is related to the position of software general manager. Column (d) is related to computer operation

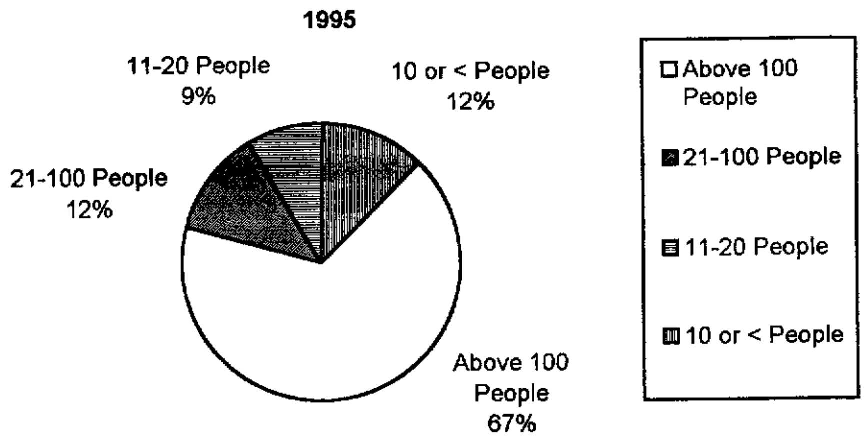


The above Figure shows that the largest number of graduates were employed as project leaders, systems analysts, systems and application programmers to satisfy the employers' demand of skills. In fact, the 1991/2/3 Associate Diploma graduates were employed as general managers, MIS specialist, project leaders, systems analysts, systems and application programmers, and computer marketing representatives. Two graduates were employed as general managers in a software house. This demonstrates that the content driven model successfully achieved its educational goals set in 1989 (p.40).

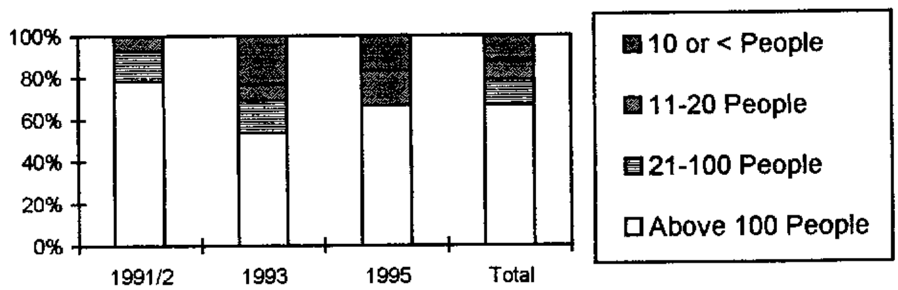
By contrast, CBT part-time students were employed in occupations which require limited design and programming skills, but more administrative and clerical skills (e.g. user supports or systems administration). However, one must take into account that these students had only recently completed their first semester CBT course and some of them may be offered in the near future more important IT positions.

Question 10h (28.d): Organisation size

	Above 100 People	21-100 People	11-20 People	10 or < People
1991/2	11	2	1	0
1993	7	2	1	3
1995	4		1	1
Total	22	4	3	4



In total, a large proportion of part-time CBT students were employed by organisations employing more than 100 people (67%).



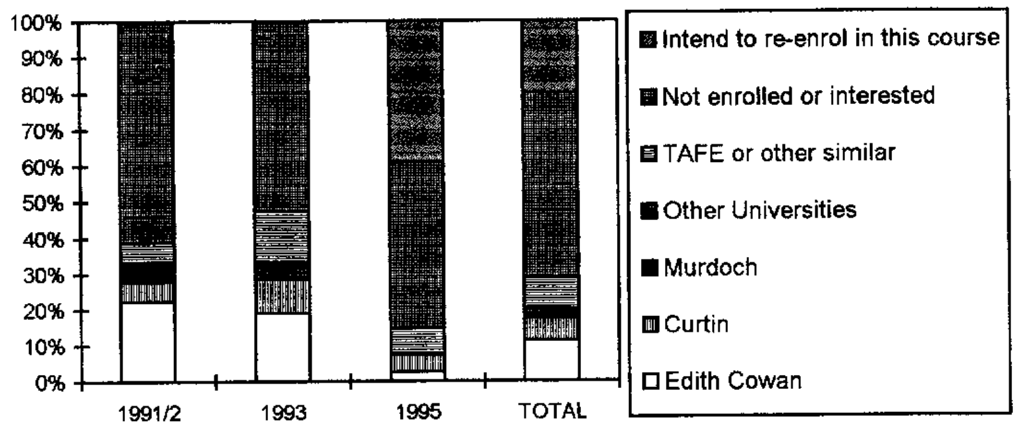
The above figure reveals that the proportion of part-time CBT students and graduates employed by organisations of varying sizes is dissimilar. About 70% of them worked for medium to large companies. This fact has some important implications for the type of employers who need to be surveyed to meet their needs. After further investigation, these organisations need graduates skilled in large and small systems, a range of operating systems (MVS, VMS, OS/400 and PC networked based operating systems), databases software (DB2, Oracle and Ingres etc.) and different hardware platforms (e.g. VAX, AS400, 466's etc.). These requirements ought to be taken into account in curriculum development.

Section 4: Further studies

This section deals with the intention of students to enrol (or re-enrol in this course) or who have enrolled in other tertiary courses in 1995. It provides the School of Information Systems with important feedback information about the students' preferences in furthering their studies, course articulation into universities and quality of TAFE IT programmes. In addition, performance indicators such as students' retention rates may be calculated.

Question 11a, b & c (30.a): These questions illustrate the preferences of courses chosen by students enrolled or intending to enrol in further studies or other courses.

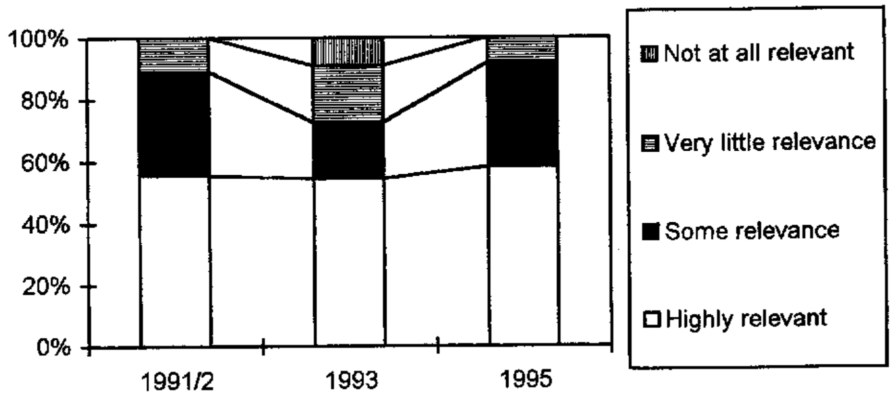
Preferred tertiary courses	1991/2	1993	1995	TOTAL
Edith Cowan	4	4	1	9
Curtin	1	2	2	5
Murdoch	1	0	0	1
Other Universities	0	1	0	1
TAFE or other similar	1	3	3	7
Not enrolled or interested	11	11	19	41
Intend to re-enrol in this course	0	0	16	16
Total	18	21	41	80



The above table and figure provide a comparison of students' and graduates' intention to enrol in tertiary institutions to further their qualifications. About 35% of the 1991/2/3 Associate Diploma computing graduates had enrolled or were interested in pursuing further studies at university. Edith Cowan University attracted most of the Associate Diploma in Applied Science graduates (around 22%). About 56% of the graduates had not enrolled or were not interested in further studies when the surveys took place respectively in 1993 and 1994. On the other hand, about 46% of CBT students had not enrolled or were not interested in further studies when the surveys took place during the second semester 1995. Fifteen percent of CBT students enrolled, in the Certificate IV course revealed that they had already enrolled or had the intention to further their studies, in universities. It is noticeable that CBT students' intention to enrol in universities decreased significantly in 1995. Students' concerns with aspects of their CBT course were discussed with each of them and these discussions are covered in the section relating to question 12 in this chapter (p.118).

Question 11d (31): Relevance of the Associate Diploma in Applied Science (Computing) and Certificate IV (IT) courses to further studies undertaken by the students. This question was analysed in conjunction with the previous question.

Relevance of this course	1991/2	1993	1995	TOTAL
Highly relevant	5	6	7	18
Some relevance	3	2	4	9
Very little relevance	1	2	1	4
Not at all relevant	0	1	0	1
Total	9	11	12	32



In Chapter 4, it was revealed that the Associate Diploma in Applied Science (Computing) was very much relevant to what the graduates were learning at university (about 70% in 1991/2/3). On the other hand, in an interview, five students already enrolled in a University course, stated that they found their CBT course somewhat or very little relevant. The other seven CBT students who intended to enrol in further tertiary studies, perceived their course highly relevant. But, a high proportion of students in this course did not answer this question because most of them did not know whether the CBT course was relevant or whether they intended to pursue further studies.

Question 11e (32): Credit received by students towards further studies (This course, degree or other Diploma courses)

Credit received	1995
Exemption(s) granted	0
No exemption(s) applied for	1
Application applied under consideration	5
Do not know	0
No answers	29
No application made	6
Total	41

CBT students did not receive exemptions before they started their Certificate IV studies. They must normally apply for credit as Recognition of Prior Learning (RPL). A small proportion of students applied for exemptions (2 students). In an interview, a further five

CBT students stated that they had applied to the School of Information Science at Edith Cowan University and their applications were under consideration, but, expressed their concern about the recognition of the CBT course by universities. One of them had received a positive response without any credit. In Chapter 4 (p.88), as expected, all of the 1991/2/3 graduates received credit towards further studies.

Question 12: Comments or suggestions made by students. Students made several comments and their comments were classified into eleven categories.

Table 5.1:
Comments made by CBT students

COMMENTS MADE BY CBT STUDENTS	NUMBER OF STUDENTS
1. Modules too short	24
2. Lack of structures and integration of the material	16
3. Duplication of material and learning outcomes	16
4. Lack of formal examination	6
5. Not enough depth in the material taught	4
6. Concerns about articulation into university and recognition of work done in this course	3
7. There is too much emphasis on traditional accounting and, workplace and safety courses	1
8. Classes are too large which means I cannot get enough help from the teacher	1
9. More in-depth in computer software would help me in my current employment	1
10. Other comments	3
TOTAL NUMBER OF RESPONDENTS	41

Note: Other comments: these are students' comments such as better computer facilities and more self paced courses not related to this study.

<u>Discussion of relevant comments</u>

Comment # 1: Modules too short

Modularisation also is closely related to the following comments: modules too short (1), in-depth learning (5), and in-depth software study (9). Twenty four students (58%) were dissatisfied with one of the fundamental principles of the CBT driven curriculum, modularisation of topics (Table 5.1, comment # 1). This is in line with the literature review and research findings introduced in Chapter Two (p. 31). Most of the CBT module sizes are fixed at 20 hours. The majority of the theoretical and practical modules such as program design, computer programming and database design must each fit into a 20 hours module. This is a major curriculum problem because the subject must be fragmented artificially and accommodated into a predetermined number of modules of fixed size, without taking into account the complexity of the content. In addition, the CBT curriculum document, does not provide a detailed list of content, but pre-specifies only learning outcomes in behavioural or generic terms.

Since the introduction of CBT, 3 GL and 4GL programming activities have decreased by fifty percent according to the course profile introduced in the third chapter (p. 43). CBT students have thus less time to develop in-depth programming skills under the guidance of teachers. Therefore, as a result of the reduction in these programming activities, CBT students expressed a lack of confidence in designing and implementing robust computer systems. After further discussions, five students, with university qualification not related to the computer field, stated that they had not gained sufficient practical skills in designing systems and programming a database in 4GL. They expected to solve business problems by using computer programming as a tool. Furthermore, the anecdotal evidence among teachers supported the claim that modularisation fosters a "surface" learning approach to computing courses.

Comment # 2: Course structure and integration

Sixteen students (39%) were dissatisfied with the structure and integration of the CBT course (Table 5.1, comment # 2). Modularisation causes fragmentation, prevents a continuity of ideas and isolates clusters of skill, without providing useful structures for the students to make connections between different ideas and skills. These drawbacks are further supported in this chapter by the results from the questionnaire about the CBT course organisation (Question 7, p. 100). Students' perceptions about module length (Sub-question 5, p. 103) and suggestions for improvement (Question 9, p. 109), indicate that the continuity of development of ideas in the CBT course had completely broken down. After further questioning four good CBT students, who had completed three database modules, admitted that they had not enough knowledge and confidence in developing a resilient database system of medium complexity in 4GL. After asking them additional questions, it was obvious that they had not an in-depth understanding of the concepts and principles of normalisation and a good grasp of 4GL programming. They had made a weak connection between theory (e.g. normalisation) and practice (e.g. programming in 4GL). Teachers involved in this study, claimed that modularisation had fragmented the structure and integration of the IT course.

Four students raised the question of excessive overloading of modules. Some topics such as information gathering in systems analysis had too few or trivial learning outcomes while data modelling and computer programming in C had to be covered in less than twenty hours. A project based on a prototyping methodology also had to be fitted into a twenty hours module.

Comment # 3: Duplication of material and learning outcomes

Sixteen students (39%) raised the question of duplicated learning outcomes across several modules. One of the major problems faced by the modularisation approach, is the question of overlapping of learning outcomes between modules. For example, some of the learning outcomes in the Data Modelling module (LOCAL) are repeated into the Relational-Logical Design (ITB402) and 4GL modules (ITA414/5). These modules are provided in Appendix B. The Australian National Training Agenda (ANTA) recommends a maximum of five learning outcomes per module. If on average one learning outcome is duplicated across these four modules, and assuming that each learning outcome is allocated 4 hours of teaching per module, it means that the equivalent of 16 hours is duplicated in four modules. This teaching duplication of learning outcomes represents 20% of the total contact hours for four modules. In extrapolating these inefficiencies across the curriculum in one semester, the total number of teaching hours duplicated is equivalent to 72 hours.

Further investigation into this duplication, revealed that learning outcomes are duplicated because they are defined in generic terms and not connected to any specific software or hardware content. In addition, students have reported cases where repetition of the same or similar learning outcomes were interpreted differently by teachers which had confused students because there was no detailed list of content. Also, the IT vocabulary is far from standardised and is sometimes open to interpretation depending on the software and hardware used, and the background and experience of teachers.

Comment # 4: No formal examination

Six students had rated the CBT assessment method very poorly and poorly. Modules are essentially project based and they are assessed by individual teacher. Each module has at least five learning outcomes fragmenting the assessment into small tasks. Comments from able students completing easily these small projects often express their concern that these CBT assignments and projects do not help them to master the computer design and programming aspects of the course. Also, students may attempt an assessment task an unlimited number of times. In CBT, there is no centralised examination system, but regular assessments for each learning outcomes are required as the module progresses. Assessments are not graded, but a "Pass" or a "Hold" is recorded. The questions of grading and assessment tasks were discussed in the literature review introduced in the second chapter. It is unknown at this stage whether the Skills Standards and Accreditation Board (SSAB) decided to enforce a grading and standardised assessment system for CBT core modules to raise the standard of the CBT course. Under the content driven model, a centralised examination system was required to maintain a high IT standards by teachers and across the colleges.

Comment # 5: Not enough depth in the material taught

Four students raised the question related to in-depth learning. After further discussion with twelve students, all but one pointed out that they had not enough time to absorb the concepts and principles of normalisation and 4GL programming. Several students pointed out that they were still not confident in designing a resilient database system. In addition, minimising the number of prerequisites lowers the standard of the course and promotes "surface " learning. The vocational policies of DEET, ACTRAC and ANTA are based on the minimisation of the number of prerequisites in the CBT courses. This system is supposed to offer more choice of modules to students, but, in fact, it generates repetition and overlapping of learning outcomes which in turn lowers the course standards. Teachers are wasting time covering the same basic principles and concepts in each module. Therefore, students do not have the opportunities to build in-depth knowledge and advanced skills.

Comment # 6: Concerns about articulation into university and recognition of work done in the CBT course

Three students who completed the first semester of the Certificate IV, applied to join Edith Cowan University and were not granted credit for the CBT modules passed. They expressed concerns about the recognition of this CBT course. This raises the whole question of articulation of CBT courses with universities. Furthermore, universities require a grading system (e.g. A, B, C, etc.) of results and want standardised assessment system of CBT courses to maintain a consistent level of standards between colleges. These above issues were raised by the Industry, Employment and Training Council (IETC).

Comment # 7: There is too much emphasis on traditional accounting and workplace and safety activities

These activities are based on the traditional accounting methods of recording financial transactions rather than on a systems approach. Students have difficulties in making connections between two different procedures, the manual approach of debits/credits transactions in the account ledgers and the system approach of managing accounting information. More emphasis should have been placed on financial statements and reports which are important instruments of managerial planning and control. A systems and computerised view of accounting (e.g. accounting information systems) would have been better. Students also have been reluctant to take the Workplace and Safety modules related solely to narrow job activities. These modules are not contributing to problem-solving skills and can be learned quickly on the job.

Comment # 8: Classes are too large which means I cannot get enough help from the teacher

One student raised the issue of class size. He felt that a classroom consisting of sixteen students each having access to a computer terminal, is too large to obtain personal assistance.

Comment # 9: More in-depth knowledge of computer software would help me in my current employment

Curriculum planning requires the integration of relevant computer theory and the corresponding appropriate software and hardware platforms. For example, if the syllabi or the CBT curricula propose to impart relational database knowledge and skills, then adequate computer software needs to be selected. Also, this software will depend on whether the course emphasises the use of personal computers, mini-computers or mainframes. Most of the CBT modules are focused on the use of software with personal computers with the exception of database modules recommended to use Oracle systems. Because this software product consists of an integrated IT methodology it is more sophisticated and cannot be learned in twenty hours. Therefore, it needs to be integrated at an early stage into the National IT Curriculum.

4. Summary

This system approach introduced in Chapter One (Figure 1.2, p. 5), consists of five group factors corresponding to the five sections which formed the basis of the survey instruments: students' educational background; students' satisfaction with their courses; employment status; and further studies.

At entry level, there was a significant increase in Year 12 students enrolled in the Certificate IV of the National IT Curriculum over the Associate Diploma (Computing). Overseas students represented only 12 % of the total student population in 1995. The proportion of students with university qualifications before attending the CBT course, increased by 4% and represented 14% of the total number of students' intake in 1995. In a discussion with five university students, they felt, for example, that they had not gained sufficient practical skills in designing systems and programming a database in 4GL. They had gained university qualifications in Arts and Mathematics, and wanted to learn how to solve business problems by using computers.

Most of the students attending the CBT course, expected to obtain a new job, improve their job or gain extra practical skills (80%). CBT students were divided on whether the Certificate IV had met their expectations in getting a job or extra practical skills such as designing computer systems and programming. They were not all convinced that the course would help them to get a job, but they acknowledged that they had just completed the first semester. Asked whether CBT students had met their objectives in undertaking a job related to their course, most of the students stated that they did not have a job yet. But, their perception was divided on whether the course had met their main objective. Five university students felt that their objectives had not been met and wanted to do more work in programming.

Teacher effectiveness indicated a high level of satisfaction with the teaching staff. They had an excellent knowledge of the material and were very effective in delivering the course. The same experienced teachers were involved in the delivery of both courses: the Associate Diploma and the Certificate IV of the National IT Curriculum. Teacher effectiveness (Sub-questions 1, 2 & 3, p. 101) attracted over seventy percent of students' satisfaction. Particularly high levels of satisfaction with the quality of teaching were demonstrated in terms of knowledge of content of the course, teaching skills and ability to relate to students. On the other hand, course organisation in CBT attracted a high level of dissatisfaction mainly due to the content of the course relevant to job, length of the modules and balance between theory and practice. Students were particularly dissatisfied with the length of each CBT module (Sub-question 5, p.103) which was too short, fragmentation of the topics, duplication of the learning outcomes, overloading and assessment method (Sub-question 11, p. 107) which had no grading system. These drawbacks are inherent to CBT courses and in line with the literature review and research findings introduced in the second chapter. The length of CBT modules (e.g. 20 hours per module) revealed very high dissatisfaction levels (20%). Students were dissatisfied with the CBT course organisation for the following reasons: course structure, coherence and integration of topics (14%), duplication of topics (14%), assessment method (e.g. no grading, 14%), module length too short and not in-depth study (10%). Overall dissatisfaction of the CBT course was reflected by 52% of the total number of students surveyed.

The CBT balance between theory and practice (Sub-question 6, p. 104) also was investigated to determine whether changes in students' satisfaction had occurred. Students' dissatisfaction (very poor and poor ratings) increased by 15%. This is due to the CBT course mix where non-computing modules such as report writing, documentation techniques and computer theory played a more important role at the expense of practical work such as designing computer systems and programming. Therefore, this has affected students' confidence in designing and programming robust computer systems (CBT students' comment # 1, pp. 118-119). It is noteworthy that there were only minor software or hardware upgrades while computer services for programming remained constant during the 1995 academic year. These factors could not have affected students' satisfaction with aspects of their CBT course.

Students' satisfaction with other aspects of their course, was also investigated. Availability of CBT module options attracted a low level of satisfaction due to limited academic and learning resources. Two CBT student submitted an application for credit towards the Certificate IV course on the basis of prior knowledge and experience. In informal discussions with past graduates and present CBT students, class sizes did not appear to affect students perception of learning in both courses.

In investigating the employment of part-time CBT students who were looking for a job related to their courses, eight of them had found a job related to their course. One student changed from fulltime to the part-time course in the second semester to start work related to his course. He stated that the course had played a part in gaining a job at the end of the first semester. Five part-time CBT students, worked in IT before they started this course. They felt that the course was somewhat relevant to their job, but would have preferred to study Oracle systems rather than MS/Access database. The use of Oracle software, as one of the market leader supplying small, medium and large organisations, was restricted due to capacity problems with the hardware and limited academic financial resources. In addition, the proportion of part-time students and graduates employed by organisation of varying size is very similar. One third of part-time students attending the Certificate IV course of the National Curriculum worked for government agencies and were employed by organisations employing more than 100 people. About 40% of the Associate Diploma graduates worked for medium to large companies. In terms of employment status, large private and government organisations seem to be particularly important for both CBT students and graduates (Question 10g, pp. 113-114). This is specifically important for part-time students (40%) attending the Certificate IV course of the National Curriculum. Large organisations need graduates skilled in small, medium and large computer systems, a wide range of operating systems, several databases software and different hardware platforms. This indicates that future occupational surveys need to consider both employers' requirements and students' opinions about future curriculum and course changes. Two part-time CBT students expressed their opinions that the database modules did not emphasise enough the use of an appropriate DBMS such as Oracle, but too much work was done on personal computers using packages such as Microsoft Access. They pointed out that most of the jobs advertised require Oracle knowledge and skills or similar expertise (e.g. DB2).

On occupation or job title, part-time CBT students were employed more as clerical staff than computer systems designers. These positions were related to user support, and system and data administration. But, these students had just completed one semester of the Certificate IV of the National IT Curriculum.

Articulation plays an important role for CBT students. Thirty nine percent of students enrolled in the course revealed that they had already enrolled or intended to pursue further studies. They had perceived their CBT modules somewhat relevant to their further studies. A high proportion of students did not answer this question because most of them did not know if they intended to pursue further studies. The results of the evaluation indicate the importance of tertiary articulation and accreditation for first year students of the Certificate IV of the National IT Curriculum. Fifteen percent of the CBT students intend to enrol in further studies at universities. These students expressed their concerns about the standard of this course and the credit transfer with universities. They found out that their CBT course was not that relevant and therefore, did not receive credit towards university studies. This may indicate that credit arrangements from TAFE to universities are underdeveloped or a reluctance from universities to recognise CBT qualifications. Also, about 46% of CBT students had not enrolled or were not interested in further studies when the surveys took place during the second semester 1995.

The following chapter revisits, compares and summarises the findings emanating from this chapter and Chapter Four. Particular attention is paid to the pattern shifting of group factors. Changes in the pattern of group factors which may have occurred abruptly, temporarily, or remained the same between the two models, provide additional guidelines about the choice of the appropriate curriculum model. Furthermore, the causes of these changes in students' satisfaction which occurred by moving from content driven to a CBT driven curriculum, are analysed, interpreted and discussed in the light of the literature review and research findings introduced in the second and third chapters.

CHAPTER 7

IMPLICATIONS, ISSUES OF FUTURE AND RECOMMENDED DIRECTIONS OF THE SECTOR

1. Introduction

This section is divided into two sections. The first section deals with short term and long term recommendations for the TAFE sector. The short term recommendations relate to immediate decisions which need to be made to improve the current CBT model in its present form. The long term recommendations involve the development of an adequate curriculum model that adapts to rapid technological changes and assists students in obtaining and retaining their jobs.

2. Short term recommendations

2.1 Course structure and organisation and technological relevance

Course sequence and length of modules, subject mix, adoption of a modern and reputable software and appropriate systems development methodologies are interrelated factors to be considered in developing an IT curriculum model.

1. Chapter Two (p. 32) indicates that curriculum planners need to be aware that courses developed on a modular basis are not always adequate for the IT discipline and sometimes are against normal business practice. In addition, Chapter Three (pp. 51-52) reveals that sophisticated systems development methodologies are appearing on the market to improve any IT project and these rigorous business system practices need to be adopted in curriculum development.

> **Recommendation One**
> It is imperative for curriculum planners to select a reputable system development methodology (e.g. SDM70) before they develop and implement an IT curriculum. This methodology is needed to facilitate curriculum planning and the integration of the course material into a coherent structure according to modern IT professional practice.

This approach forms the groundwork for the next recommendations.

2. Chapter Three (Table 3.12, p. 55) reveals that DB2, Oracle, Informix, RDB and Progress, are increasing their market share in relational database software and represent about 60% of the total market share. A substantial proportion of graduates and part-time CBT students work for large organisations (Chapter 5, pp. 114-115).

These organisations need skilled professionals in both large and small computer systems, a range of operating systems, databases software and different hardware platforms. This has economic implications for educational institutions because it is not economic to service a wide IT market and it is preferable to concentrate on a market niche and cater for a particular domain. Therefore, course structures ought to be developed around a reputable database software such as Oracle, Ingres or another which allows system integration across different industries and organisation sizes.

Recommendation Two
Firstly, a structured instructional analysis ought to integrate an appropriate relational database software into the CBT course at an early stage of the curriculum development. A DBMS such as Oracle is recommended because it incorporates comprehensive system and programming development methodologies including CASE tools but other less complex software products such as Ingres or Progress may be more economical. Secondly, the course, whose very existence is based on technological changes, must be reviewed continually for currency and relevance. Thirdly, to avoid confusion over IT terminology within the course, a detailed list of content (e.g. syllabus) to be learned needs to be clearly defined.

3. Chapter Five (Question 9, p. 109 and Table 5.1 p. 118) reveals that a substantial percentage of CBT students are dissatisfied with module size. Twenty teaching hours allocated by the National IT curriculum to each module appear to be too few to enable learners to absorb and apply complex design knowledge and complete their assignments. A reasonable amount of time must be allocated to learn the software design methodology (e.g. CASE tools) and to program in 4GL. For example, database design and 4GL programming modules require at least 45 hours to avoid a 'surface' approach to learning (Chapter 2, pp. 12, 17 & 31).

Recommendation Three
Cognitive activities need to be clustered into larger modules to avoid fragmentation of instructional ideas and topics. Overlap and redundant material must be eliminated. Following this, a reasonable amount of time needs to be determined for each module/unit.

4. The comparative survey results in Chapter Six (Figure 6.1, p. 128 and Table 6.7, p.138) demonstrate clearly that it is not a good idea to focus solely on narrow technical and job related skills at the expense of general education. General education is intertwined with vocational and technical education and is needed for successful employment as IT professionals. Project leaders, systems analysts and programmers need to be equipped with mathematical and communications skills underpinned by general mathematical, business and communications knowledge (Chapter 2, Table 2.1, p.20). A background in the disciplines of Accounting and Economics (e.g. cost benefit

analysis) is required for database designers to enable them to produce effective and efficient business information systems.

Recommendation Four
In an integrated curriculum, subjects ought to be linked horizontally while they are simultaneously developed in-depth. General knowledge ought to be identified to support vocational and technical knowledge and other special IT skills (e.g. Spreadsheet). For example, the database design subject should be linked horizontally across a range of general subjects such as Mathematics (e.g. relational algebra) and Economics (e.g. cost benefit analysis).

5. Chapter 2 (p. 22) suggests an integrated approach to curriculum development drawing on different disciplines. Also, a balanced course between design/programming and other subjects needs to be developed. For example, computer programming played a major role in assisting the Associate Diploma in Applied Science (Computing) students to achieve better results in the area of designing systems and building algorithms (Chapter 3, Figure 3.4, p.46). Graduates were highly satisfied with aspects of their course (Chapter 6, Table 6.7, p.138). This course was also successful (Chapter 4, p. 79). Research in Cognitive and Information Science Education reported in Chapter Two (pp. 13-15), emphasises both cognitive processes and an adequate amount of time for programming activities.

Recommendation Five
A balance between general, vocational and technical education should be restored as follows:

• Programming in 3GL	40%
• Computer systems theory	30%
• General education	15%
• Database design (CASE tools) and SQL	8%
• Computer project	7%

6. The vocational policies of DEET, ACTRAC and ANTA are based on a minimisation of the number of prerequisites in the CBT courses (Chapter 5, p. 92). This system is believed to offer more choice of modules to students, but, in fact, it generates repetition and overlapping of learning outcomes which, in turn, lowers the course standard. The comparative survey results in Chapter Six (p. 141), reveal that a reduction in the number of prerequisites promotes "surface " learning. The CBT model is also inefficient because teachers are wasting time in each module to cover the same basic principles and concepts. Consequently, students do not have the opportunities to build in-depth knowledge and advanced skills. Prerequisites are necessary to allow in-depth study in designing systems and programming.

Recommendation Six
Appropriate prerequisites for each subject/unit must be determined to allow in-depth learning in areas of computer system design and programming.

7. Given that most of the students are from Year 12 or qualified with degrees, the Certificate IV appears to offer too many trivial and narrow job related modules as core units (See CBT curriculum and course structure in Appendix B). These core modules are related to Word Processing, Spreadsheet and other software where learning outcomes emphasise solely the use of features of these computer packages. These learning activities consist of a low level of thinking and use up valuable teaching time which is not assisting learners to become better problem-solvers.

Recommendation Seven
The standard of the Certificate IV course should be raised to take account of the entry level and ability of the learners. Also, more time should be allocated to assist learners to concentrate in-depth on designing systems and programming. This can only be achieved by eliminating irrelevant core modules (e.g. Word Processing, Spreadsheet and Writing Workplace Documents etc.) from the Certificate IV course. Then, the time saved can be re-allocated to the teachers to concentrate on the learning process of high order of thinking such as that required in system design and programming.

8. Chapter Six (Table 6.9, p. 149) indicated that, on average, one third of the Associate Diploma in Applied Science (Computing) graduates and to a much lesser extent, CBT students, are eager to pursue further studies at universities to gain additional qualifications in Information Systems or Computer Science. In the past, a substantial number of the Associate Diploma in Applied Science (Computing) graduates had enrolled at Edith Cowan or Curtin universities, completing their degree courses successfully (Chapter 4, p. 88). By contrast, the CBT course structure and organisation affects a range of factors (Table 6.7 & pp. 138-145) which contributes to ineffective learning and, in turn, reduces students' confidence in developing efficient computer systems. The CBT approach decreases the motivation of students and discourages them from striving for further studies because they are aware that their CBT course is, in reality, not conceived to articulate with universities.

Recommendation Eight
The TAFE course ought to articulate with university courses which are using modern software such as Oracle and Ingres.

2.2 Learning and teaching flexibility

9. Fragmentation of the CBT course affects the assessment methods as competencies need to be assessed as many and small separate learning outcomes. This ad hoc approach is performed at the expense of more large scale complex assessments (holistic) which restrict teachers in developing and submitting medium/complex information system problems to students. This restriction can only be overcome by lengthening the CBT modules. In addition, because the assessment of competent performance is dependent on the teacher's subjectivity, standards of principles of professional judgement are also very much dependent on the knowledge and experience of individual teachers as there is no centralised examination system in CBT to maintain standards across the colleges. The Skills Standards and Accreditation Board (SSAB) are concerned and agreed to register the CBT course in Western Australia under the conditions of introducing a standardised assessment and grading system for CBT core modules. A lack of assessment methods and non-graded assessment appear unacceptable at this stage to employers and universities because it will increase their selection cost.

Recommendation Nine
In order to maintain standards, a centralised system of assessment should be established. To achieve this, experienced examiners need to be appointed.

10. Chapter Six (Table 6.6., pp. 136-137) reveals that, under the CBT model, teachers' roles and the nature of their work are considerably restricted for several reasons. More emphasis is attached to learning outcomes instead of cognitive structures and processes. This is aggravated by the modularisation aspects of the course resulting in fragmentation. The literature review in Chapter Two (pp. 31-34) and the comparative survey results in Chapter Six indicate that the modularisation approach has built-in flaws which restrict learners in their intellectual development. Therefore, CBT students may be unable to solve information systems problems, but perform only simple and narrow technical tasks because teachers have not enough time to identify students' needs and build their knowledge base. By contrast, the content driven model had provided teachers with opportunities to develop teaching strategies to make connections between theory and programming, provoke abstraction, facilitate problem-solving and transfer skills. Transfer of skills occurs only when students are helped by teachers to think about programming at an abstract level by using symbolic notations. Teacher involvement is therefore important because in many IT situations there is no one right answer to issues and problems. The literature review from Chapter Two (pp. 12-16; p. 24) and research findings emanating from Chapter Five, warn that, if IT is not used adequately as a cognitive enhancer, students will be unable to solve problems and adapt to a rapidly technological changing workplace.

Recommendation Ten
The central role of making judgements in terms of pedagogical approach (p. 137: p.152) must be given back to teachers, because they must assist students to move constantly from coding to design and vice and versa, draw on their experience, and make constant connections between theory and practice.

11. The Australian Association of TAFE Managers (Senate Employment, Education and Training Inquiry into ANTA, 1995, p. 66), stated that the introduction of CBT may not be appropriate to all learning disciplines (e.g. Management Studies). In the same inquiry, the Australian Council for Private Education and Training (1995, p. 21) stressed that there is little divergence or innovation possible in delivering vocational skills for emerging industry practice. The ultimate outcome, if this rigid conforming continues, will be a stifling of creativity in training and content which has the potential to lock Australia into a non-competitive global practice, the opposite of what Government reforms aim to deliver. The promotion of creativity will depend on whether the curriculum model allows for a wide range of conditions to be implemented. These may include an adequate course mix and time allocation to the learning process, appropriate prerequisites and teachers' autonomy to make judgements. Learners must be able to demonstrate that they also are able to make judgements and are capable of self-assessment.

Recommendation Eleven
Skills related to the capacity for independent, original, and critical thinking should be developed. Teachers must get the opportunity to upgrade, on a regular basis, both their IT and teaching skills in order to assist students to promote creativity. This question of creativity in IT needs to be further explored.

12. Chapter Two (p. 19 & Table 2.1, p. 20) reveals group and interpersonal competencies need to be emphasised as students learn from each other. Under the content driven model, teachers had the time and freedom to organise group assignments, however, by contrast, the CBT approach does not indicate whether group work activities should be encouraged.

Recommendation Twelve
Group work ought to be promoted by teachers and appropriate time allocated for this type of activities.

3. Long term recommendations

1. The lack of consultation with teachers during the curriculum development and implementation of the CBT course is well documented in the literature review in Chapter Three (pp. 62-63). Chapters Five and Six demonstrate that this CBT model

had resulted in students who are highly dissatisfied with aspects of their course, and in disappointed teachers.

Recommendation One
Views of teachers, learners, and graduates need to be sought when educational reforms have the capacity to affect the structure, coherence and integration of instructional activities.

2. The literature review on Information Science Education (p.22) suggests that the development of vocational courses should be based on industrial project work which allows students to integrate various modules and gain work experience. This requires the close cooperation of all stakeholders. This approach needs teachers who are well qualified and have industrial experience in computing and who have gone through system design and programming activities several times.

Recommendation Two
Employers including software and hardware suppliers should participate in course planning and delivery. Alliances or agreements should be made between colleges and organisations to promote industrial experiences for teachers and allow final year students to participate in industrial projects.

3. CBT proponents suggest an alternative route to accreditation to the traditional tertiary courses (e.g. Associate Diploma in Applied Science). To be more closely related to the fast changing IT world, they recommend an assessment system based solely on industrial competence. Chapter Two (p. 34) has demonstrated that there are no standards or principles of professional judgement that can inform competent action in the context of uncertainty and change. Survey results from Chapter Five also have demonstrated that competencies based solely on narrow job related activities without knowledge and deep understanding may produce inept learners when required to adapt, solve problems or innovate. However, there are some industrial organisations such as Oracle and Microsoft offering Master programmes which are solely work-based. These training programmes are given for a specific release of the software. This means that the college may have to establish cooperative arrangements for integrated work-based assessment like the collaborative training partnerships established between education and industry in the UK.

Recommendation Three
The sector ought to form training partnerships with IT industries to include some of the subjects offered in their Master programmes. This may give the opportunity to students to gain industrial experience and develop projects in conjunction with industry. Furthermore, industrial experience should count towards some of the final academic qualifications. As an alternative route to accreditation, evidence of tasks completed through these industrial Master programmes should be further explored.

4. The curriculum model needs to be followed-up to make appropriate improvements. In this study, the following components have been identified as being important (Chapter 1, Figure 1.2, p. 5):

   input factors

   - educational background or entry level;
   - teacher effectiveness;
   - course structure and organisation;
   - technological relevance; and
   - learning and teaching flexibility.

   These input factors affect, in turn, students' satisfaction with their course and also the following groups of output factors:

   - students' employment status;
   - preferences to further studies; and
   - skill transfer and ability to adapt.

Recommendation Five
Surveys should be used regularly to evaluate the course. These surveys could be based on the NCVER and WADOT questionnaires used in this study.

4. Conclusions

This study has provided the sector and other tertiary educators in information science with a comparison of how Associate Diploma in Applied Science (Computing) graduates and CBT students are equipped to meet the requirements of a rapidly changing technological workplace. Over the years, a paradigm shift towards more technical training types of courses has been identified, although the content driven model appears to be the best approach for providing a relevant and responsive approach for both students' satisfaction with aspect of their course and employers' requirements to a rapidly changing technological workplace. But, with the introduction of CBT, it is apparent that the initial hopes and expectations of a modular system have been unrealistically high as is reflected by the amount of disappointment reflected in student surveys and in the literature. The results of the comparative survey in Chapter Six were reinforced by the current literature in Cognitive Science, Instructional Theory, Information Science Education which suggests that the CBT system had curriculum flaws and inherent weaknesses. It was also reported by teachers that they preferred the content driven model because they could prepare lessons directly from a detailed syllabus and had autonomy in the way they wanted to teach the subject. This means, that if teachers are forced to implement the current CBT curriculum, they will move towards a system which promotes the demonstration of generic competencies expressed in terms of learning outcomes or behavioural objectives instead of a system of building organised knowledge and processes in the students' minds. It is, therefore, concluded that the content driven model is the most appropriate to train

IT professionals. This is a relevant message on implementation for Finn and ANTA educational policies which had been established on managerial efficiency (p. 30), solely, and not on effective learning and teaching models to satisfy both students' needs and employers' requirements.

This study has provided the readers with some pitfalls that may be expected when implementing a new curriculum model based on the CBT. Furthermore, skill categories and highly ranked individual skills should be nurtured more actively in new educational programmes in information science. Perhaps, a combination of content driven curriculum development with a CBT approach, linking the content to the CBT learning outcomes and incorporating the skill areas which are found to be more valuable, would be a viable approach to solve the current IT educational problems in the sector.

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APPENDIX A

ASSOCIATE DIPLOMA IN APPLIED SCIENCE (COMPUTING) COURSE AND EXAMPLE OF A SYLLABUS

APPENDIX B

COMPETENCY BASED TRAINING (CBT) DOCUMENTS

APPENDIX C

NCVER QUESTIONNAIRE FOR THE ASSOCIATE DIPLOMA IN APPLIED SCIENCE IN COMPUTING; 1994 CLIENT FOLLOW-UP SURVEY

APPENDIX D

1995 CLIENT FOLLOW-UP QUESTIONNAIRE FOR THE CERTIFICATE IV OF THE NATIONAL INFORMATION TECHNOLOGY CURRICULUM (CBT)

GLOSSARY AND LIST OF ACRONYMS

ACM	Association of Computer Manufacturers
ACPET	Australian Council for Private Education and Training
ACS	Australian Computer Society
ACTRAC	Australian Committee for Training Curriculum
AMTC	Advanced Manufacturing Technology Centre
ANSI	American National Standards Institute
ANTA	Australian National Training Authority
ASF	Australian Standards Framework
Attribute	In the context of education, a holistic approach to integrated nature of knowledge and skill or competence
AUSTAFE	Australian Association of TAFE Managers
BCA	Business Council of Australia
CAL	Computer Assisted Learning
CAI	Computer Assisted Instruction
CASE tools	Computer Assisted System Engineering. This software facilitates the task of the systems analyst by automating the design and coding of computer activities.
CBT	Competency Based Training (CBT):
CML	Computer Managed Learning
Competence	The attributes (knowledge, skills and attitudes) which enable an individual or group to perform a role or a set of tasks to an appropriate level of standard.
Course organisation	Refer to key survey questions based on the NCVER and WADOT questionnaire used in this study.

Course profile	Amount of time allocated to each general, vocational, technical, theoretical and practical subjects in relation to the total delivery time. It also relates to subject mix.
Course structure	Hierarchy of concepts of the discipline with the more abstract concepts at the top of the pyramid of concepts.
Curriculum	Training curriculum derives directly from the job or tasks to be learned. There is a range of techniques, such as Task Analysis to increase the rigour and validity with which jobs and tasks are analysed for input to curriculum design and development.
Curtin	Curtin University of Technology
DACUM	Developing a curriculum is a process of curriculum development.
DBMS	Data Base Management System (e.g. Oracle, IBM DB2, Ingres etc.)
DEET	Department of Employment, Education and Training
ECU	Edith Cowan University
Entity-Relationship	The constructs and convention used to create a model of the Model user's data. The results are documented in an entity-relationship diagram which may be developed through computer software (e.g. Oracle CASE tools)
Fourth Generation Language (4GL)	A non procedural language such as SQL. For example, this language is used by Oracle or other similar DBMS.
IETC	Industry and Employment Training Council
MIS	Management Information Systems
NBT	National Board of training
NBEET	National Board of Employment, Education and Training
Performance	The professional opportunity to present a case for competence within a teaching learning context.

Life long learning	Students are exposed to an environments which encourage active and deep understanding, while a surface approach involves learning by rote and relies on memorising (NBEET, August 1994, p.1).
RPL:	Recognition of Prior Learning
SALSA	Development tool to generate schemas for various DBMS products. See references p. 168.
Semantic Object	The constructs and convention used to create a model of the user's data.
SQL	Structured Query Language
SSAB	Skills Standards & Accreditation Board. The board consists of representatives of the State Government, employers, unions, universities (Curtin and Edith Cowan) to endorse new courses.
System development methodology	A framework for Information Technology professionals to design implement and maintain computer systems for end-users (e.g. SDM 70, Pride LOGIK, Oracle etc.)
Model	In database, the results are documented in an object diagram which may be developed through computer software (e.g. SALSA CASE tool). In curriculum, means all the components of an educational system (e.g. Figure 1.2, p. 5).
Standards	The expectations of the profession in order that quality assurance might be provided for students.
Syllabus (CBT)	CBT document consisting of list of learning outcomes (or behavioural objectives) and criteria to be met by the learner. Under the content driven model, it means a list of detailed content that students have to learn.
TAFE	Technical and Further Education
Third Generation Language (3GL)	Procedural language such as Pascal, C or Cobol.
WADOT	Western Australian Department of Training