Using multimedia microworlds to motivate and engage adult learners

Susan B. Stoney

*Edith Cowan University*

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Using Multimedia Microworlds To Motivate And Engage Adult Learners

Susan Barbara Stoney
TDipPs, Dip Bus St (STC), B.Ed (Nedlands CAE), M.Ed (UWA)

Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy, Edith Cowan University
Faculty of Science, Technology and Engineering
June, 1998
Abstract

As educational institutions come under increasing pressure from outside forces to restructure the way students learn, efforts are being made by researchers to find ways to assist students to learn through independent thought and to solve problems in a resource-based, self-paced environment. Such an environment needs to be sufficiently interesting and novel to motivate students who begin to use it, and to continue to engage them as they progress through it.

This study has sought to identify what such a learning environment needs to encompass in order to motivate and engage adult learners so that they will not only want to use it, but use it extensively. Eight attributes of motivation and engagement were identified from the literature, these being: immersion; reflection; flow; collaboration; learner control; curiosity; fantasy; and challenge. A module in a finance unit traditionally viewed by the students as boring and unengaging was selected, and a review of student and content needs was conducted. An interactive learning environment in the form of a microworld with gaming elements was designed and developed to incorporate the eight learner effects, and this was then trialed with a small group of finance students. The trial forms the basis for this thesis.

The study was conducted using a combination of ethnographic action research and grounded theory as these allowed the researcher to focus on a specific problem relevant to the actual situation and allowed patterns in observations to be detected. The study used descriptive methodology to report what actually happened whilst looking for relationships between design elements, with cross-sequential sampling overcoming the problems of mono-operation bias.

The results from these data gathering exercises suggested that the eight learner effects did, in fact, contribute to motivation and engagement in varying degrees.

The program represented the unit content in a multiplicity of ways, ensuring that the individual learning styles of the students were accommodated. The study showed that students adapted differing navigational methods to progress through the program, but having settled on a path tended not to deviate from that path throughout each phase of the program.
The study also highlighted the fact that such an environment is probably more effective in promoting incidences of reflection and higher order thinking among collaborating students, although, with sufficient scaffolding elements built into the program, students working in isolation may achieve some of the same effects from collaboration with the program itself.

Another effect of using the microworld was that students could relate their learning back to their everyday lives, as well as place themselves into the environment. These factors, combined with the gaming elements, created an environment that caused an increase in positive attitudes among both the male and the female students.

The results of this research have many implications for the future design of interactive learning environments for adults. It is already well documented that adult learners like resource-based, self-paced learning that is available at their convenience, but this research has identified some of the elements necessary to motivate adult learners to use such a program, to maintain their interest in the content during the whole time they are using the program, and to create a desire to continue learning about the topic long after they have completed the program.

There are several imperatives driving the development of interactive instructional multimedia in the university environment. Among them are increased numbers of students, a reduction in the available face-to-face teaching time, and a growing number of students who are demanding a more flexible way of learning. The results of this study show that interactive multimedia is a viable option for this style of teaching and learning, but the design should incorporate certain elements and principles in order for the students to be motivated sufficiently to use it. These design elements are generalisable to the design of multimedia for a wide variety of courses and topics.
Acknowledgments

Without the help, support and encouragement of a great many people, this thesis would never have been started or completed and I would like to take this opportunity to publicly thank those people.

I owe an enormous debt of gratitude to Associate Professor Ron Oliver, my patient and long suffering supervisor, who not only persuaded me to begin this research, but who also provided constant, prompt and supportive feedback which maintained my enthusiasm and direction.

Associate Professor Yvonne Melotte from the Faculty of Business at Edith Cowan University not only gave me the initial impetus, but also some funding to begin a project which metamorphosed into this study. Her interest and encouragement are enormously appreciated. I was also extremely fortunate that the Faculty of Business and Professor Janice Burn granted me sufficient leave to enable me to complete this study, and I wish to thank them for the opportunity.

And finally, my family, who have put their lives on hold waiting for me to finish. I cannot thank my husband, Mark, and my sons, Thomas and Archie, enough for their caring, support and encouragement and for tolerating all my messy emotions (not to mention burnt dinners!) with understanding and tolerance.
Declaration

"I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution in higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text."

Signed:

Date: 12/11/98
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Chapter One

There has been a great deal of research conducted on the efficacy of one instructional design over another, but very little has been conducted by using an innovative technique such as interactive multimedia (IMM) which has been further broken down into a variety of instructional strategies that can be adapted to suit the individual, adult, learner.

Adults learn most effectively when they have a need for the new information or knowledge. They do not like to learn material in the hope that they might need to know the information "one day". They need to know why they are being asked to learn something and want to know what the benefits will be before they begin learning (Stilborne & Williams, 1996). The implications of this, are that, in order to be motivated and engaged, adult learners need to recognise and identify with the relevance and realism of the material they are being asked to learn. This makes multimedia an ideal medium for teaching adult learners, but often its unique features are not utilised effectively in this regard.

This thesis describes the process undertaken to determine what was necessary to build into a multimedia program in order to attend to the affective needs of learners, as well as the cognitive needs. The first factor explored was what were the types of elements likely to motivate and engage adult learners. An extensive literature review was conducted, and from this eight elements or learner effects were identified. These then formed the theoretical basis upon which a learning environment was created, and the ways in which adults used it and how well it motivated and engaged was explored.

This study involved the development of an interactive multimedia program which included the attributes distilled from the literature as being most effective for promoting motivation and engagement in adult learners. It aimed to investigate the extent to which an IMM environment containing all of the eight following learning effects, motivated and engaged the students:

- Immersion
- Reflection
• Flow/play
• Collaboration
• Learner control
• Curiosity
• Fantasy
• Challenge

The study examined closely these learner/treatment interactions and attempted to find differences in the ways in which different students used the program. These were then related back to motivation and learning outcomes.

The program incorporated the above learner effects through educational and program attributes. These features were planned to achieve learner motivation and engagement as well as providing students with an educationally sound program of instruction. The program, which took the form of a microworld, used authentic activity and anchored instruction to situate students in a simulated environment through which they were able to learn with a sense of realism.

The microworld studied was based on an introductory finance module and allowed the learners to choose between guided discovery (such as hints and tips and on-line characters) or total learner control where the learner could use exploration to discover the necessary learning elements. Students were able to elect the degree to which they utilised the hints, and were able to use it as scaffolding at the beginning with a degree of fading as their competence grew. All students were given the same program to complete and their movements were tracked to determine to which extent they used the hints, and at what points.

Statement of the Problem

Interactive multimedia (IMM) is gaining widespread use as an instructional medium for the flexible delivery of education and training in universities and higher education. While the medium is very popular among young users, studies have found that adult learners are not nearly as enthusiastic about learning with multimedia as their younger
counterparts. Both students and teachers see multimedia as programmed learning revisited, rather than a serious and long-term strategy for developing knowledge bases. Adult learners tend to be more focused in their reasons and purpose for study (cf. Knowles, 1978), they have less time to contribute to their studies and are much more interested in what they are learning than the actual process of learning. While instructional designers of children's software often build motivating and engaging learning environments for their clients, the developers of interactive multimedia materials for adult learners do not generally have a formal motivational plan.

The complications to learning are the human variables of needs, emotions, attitudes, expectancies, beliefs and values, cultural contexts and cultural learning styles (Wlodkowski, 1993:14; Henderson, Patching & Putt, 1994). These are also the motivational variables and should therefore be taken into account when designing multimedia. So, whilst there is a plethora of IMM products, they do not appear to attend to ongoing motivation within the instructional design. A motivational plan needs to be in place for the entire program, not just the initial few screens (Wlodkowski, 1993). Without this attention to the learner's affective needs as well as cognitive needs, the programs are often boring leading learners to avoid them in preference to face-to-face contact with a lecturer in class.

The problem, then, is that whilst enormous amounts of time and money are being expended on developing instructional multimedia, very little attention is being paid to motivation and engagement (Dempsey, 1994). Most of the development efforts are focussed on the cognitive domain. As educational institutions move towards alternative delivery systems and as adult learners demand more self-paced and resource-based learning, there will be increasing pressure to produce instructional multimedia materials which can meet all the needs of the learner. As Laurillard, (1995) claims, "multimedia is sometimes seen as a way of re-purposing material originally developed for narrative media ... the learning objectives [should be] re-constructed if the new medium is to achieve its pedagogical potential and offer a new kind of learning experience to students" (p. 179).

One of the earliest insights into educational technology was that it increased the possibility of individualising the educational process to accommodate the needs,
interests, current knowledge, and learning styles of each student. One advantage of using interactive multimedia in the classroom is that of self-pacing which obviates the need for teachers to target their presentations to some hypothetical "typical" pupil, leaving part of the class behind while other students become bored, restless and inattentive (Shaw & Bransford, 1977; Shaw et al, 1997).

In recent years there has been much more focus by researchers on the potential of technology to support fundamental changes in the models underlying the traditional approach to education.

- Greater attention is being given to the acquisition of higher-order thinking and problem-solving skills, with less emphasis placed on the assimilation of a large body of isolated facts.

- Basic skills should not be learned in isolation, but in the course of undertaking (often on a collaborative basis) higher-level "real-world" tasks whose execution requires the integration of a number of such skills. Information resources are made available to be accessed by the student at that point in time when they actually become useful in executing the particular task at hand (Shaw, 1997).

- The student is much more active in building his or her own knowledge and skills, rather than passively absorbing information transmitted by the teacher (Wittrock, 1974).

The problems, then, are of encouraging students to manage their own learning, rather than being taught; using skills and solving problems in the context of the practical application of the theory; and de-emphasising the learning of large amounts of information which leads to shallow learning, rather students should develop transferable skills of higher order thinking, decision-making and problem solving.

Using technology is one solution to the problems outlined above. However, although technology gives students a degree of personal autonomy, programs that do not take into account the affective domain will fail to engage students at a deep level, and will therefore fail to stimulate an on-going desire to learn.
Rationale/Significance

Employers are now requiring universities to produce students with a different set of skills from those emphasised in early twentieth century pedagogy. These skills include, not only the ability to use computers to access information, but to use them to access pertinent information. Any business graduate, and indeed any student working in a competitive environment, will rely on information to make key decisions and solve problems (Robbins & Mukerji, 1994). New graduates from universities are now faced with using Management Information Systems, Executive Information Systems and Expert Systems, they will need to find their way around a variety of user interfaces and actively seek and summarise information from a multitude of sources both from within and without the organisation—all of it accessed from their computers.

Incorporating interactive multimedia into University teaching and learning is not just driven by this need to reflect the direction in which society and organisations are moving, but also the need to reduce overheads within the University environment itself. Increasing international competition for students impels educators to review some of their more traditional teaching methods and at the same time create courses which can be taken by students both internally and externally. This philosophy is well recognised by the Governments of most developed countries with the following recommendations being made by the President's Committee of Advisors on Science and Technology in the USA:

- The focus should be on learning with technology, rather than about technology;
- The emphasis should be on content and pedagogy, not just hardware;
- Equitable and universal access is paramount;
- Experimental research on educational technology is necessary

The solution to the problem of producing intrinsically motivating material is to examine the needs of the learners and attempt to fill those needs whilst producing a theoretically sound program. The personalisation principle as expounded by Moore & Anderson (1969) shows that a learning environment should be both responsive and reflexive, permitting free exploration at the learner's own pace, with immediate feedback, and allowing the learner to discover relationships between different types of knowledge.
Many adult learners need a flexible and self-paced approach to learning and one of the benefits of resource-based delivery systems is that they provide a mechanism for the flexible delivery of course materials, either in a classroom situation, or via long-distance learning (Duffy, Lowyck, & Jonassen, 1991; Galbraith, 1991a). The advantage of this is that students in remote locations can be receiving the identical instruction as those students on campus. Students can also get the program in their own time and undertake the coursework at their own pace.

This need for independent, self-directed study is well recognised amongst the proponents of adult learning theory (eg. Knowles, 1978; Knowles, 1980; Wlodkowski, 1993). Multimedia can also fulfil the need for lifelong learning which many adults now experience due to the huge strides being taken in technology and the resultant changes to the workplace (eg. Fassig, 1994; Keys, 1994; Knowles, 1978). Businesses require universities to produce students with very different skills from those required just ten years ago. Organisations are now linking learning to productivity, rather than training (Johnson cited in Reinhart, 1995) and this new learning is typified by two-way, collaborative and interdisciplinary information flow rather than the one-way flow currently considered the norm (Reinhart, 1995).

The student population of universities has also gradually changed to become more multicultural and thus created a need for curriculum developers and instructional designers to take cultural-inclusivity into account (Parker, 1996).

While multimedia holds all the promise of fulfilling many of the motivational needs of the adult learner, the reality to date has been rather different. Many multimedia program developers take the existing information and simply convert it to multimedia thereby creating an electronic "page-turner". Reigeluth (1993) points out that there may be motivational strategies, as yet largely unexplored in the literature, that are unique to multimedia, but the motivational effect of teaching strategies such as multimedia and games is only transient, and that the initial motivation that they invoke quickly diminishes (Thomas & Macredie, 1994). A possible reason for this may be that the multimedia designers are not taking into account that motivation is dynamic and the motivational needs of students change as the learning process unfolds. Another reason may be the "novelty" effect of multimedia which wears off either through familiarity
with the technology or through the tedium of clicking through endless screens of uninteresting material.

The movement towards multimedia mirrors the computer based learning trends of the 1970s when computer based learning (CBL) and computer based training (CBT) were seen as the answer to some of the already recognised problems of providing a flexible learning system, but in reality did not meet the expectations. Indeed Tucker (1990) was moved to describe CBT as “narrow pathways laid down in dark forests by long dead teachers”. CBL and CBT were found to be far too mechanistic, over engineered and demotivating (Tucker, 1990). In order to overcome this problem with IMM, there must be some strong educational theoretical frameworks applied which consider not only the cognitive domain of the learner, but the affective domain as well. The literature suggests that the two domains are interdependent with the learning process and that humans have a basic need to feel emotionally engaged (Csikszentmihalyi, 1990; Goldfayl, 1995).

Multimedia has the ability to provide students with information that is relevant, which provides them with elements of personal control, promote feelings of competence and effectiveness, and provide a vehicle by which to explore and stimulate curiosity. However, do these attributes encourage higher levels of engagement and continuing motivation than instructional materials without them? Kinzie (1990) suggests that “more research is needed on these elements and their relationship to continuing motivation” (p 18).

A review of the literature on instructional multimedia and gaming by Dempsey (1994) showed that the majority of articles were based on discussion and that very few of them were related to development of multimedia and even fewer focussed on learner characteristics, particularly cognitive styles or cultural differences. In the period under review, (1982-1994), most discussion was about simulation with the least discussion involving motivation. Whilst the development and use of simulation games and microworlds are likely to increase due to their paralleling current research into situated cognition and anchored instruction, where knowledge is believed to be inseparable from context, attention to other factors such as motivation and learner characteristics must be made (Brown, Collins, & Duguid, 1989). Modern educational concepts based on the work of Piaget, Papert and Vygotsky emphasise individualised, hands-on learning;
teamwork; and guided discovery of information, and although technology alone is not the solution, it can make a significant contribution in incorporating the above into a new educational paradigm. The following table adapted from (Reinhart, 1995) illustrates this changing paradigm and identifies some of the technological implications:

<table>
<thead>
<tr>
<th>Old Model</th>
<th>New Model</th>
<th>Educational Implications</th>
<th>Technology Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom lectures</td>
<td>Individual exploration</td>
<td>Self-paced, students need to have initiative and curiosity</td>
<td>Networked PCs with access to information</td>
</tr>
<tr>
<td>Passive absorption</td>
<td>Apprenticeship</td>
<td>Learning &quot;in situ&quot;</td>
<td>Requires skills development and simulations</td>
</tr>
<tr>
<td>Individual work</td>
<td>Team learning</td>
<td>Social skills and attention span</td>
<td>Benefits from collaborative tools and e-mail</td>
</tr>
<tr>
<td>Omniscient teacher</td>
<td>Teacher as guide</td>
<td>Technology enhances teaching and supplements traditional teaching methods</td>
<td>Relies on access to experts over networks</td>
</tr>
<tr>
<td>Stable content</td>
<td>Fast-changing content</td>
<td>Content redesign to accommodate technology</td>
<td>Requires networks and publishing tools</td>
</tr>
<tr>
<td>Homogeneity</td>
<td>Diversity</td>
<td>Design of innovative curriculum to promote active learning</td>
<td>Requires a variety of access tools and methods</td>
</tr>
</tbody>
</table>

Interactive multimedia is an ideal vehicle by which to exploit the symbiosis of the cognitive and affective domains of adult learners, but in light of the technology implications outlined above, the motivation and engagement of the learner need to be addressed in the design of the program so that the effectiveness of the learning experience can be maximised.

The problem then, is how to design and develop an interactive multimedia program that attempts to take into account the individual characteristics of learners, that accommodates the technological implications stated in Table 1.1, and has the ability to motivate and engage adult learners.

**Clarification and Analysis of the Problem**

In order to analyse the problem to solve it, it had to be clarified and expanded into its various components. The assimilation of background information concerning the problem then becomes essential (Baumgarten, 1986). The formulation of research questions involves consideration of some of the following: a statement of what the problem is; possible causes of the problem; the relationship of the problem to previous
research; and the relationship of the problem to a theoretical framework (Baumgarten, 1986).

Clarifying the problem entailed background reading and intense introspective study which allowed the researcher to determine the steps to be taken to solve the problem. Questions such as what information is needed, from whom or where the information should be obtained, the uses to which the information will be put and how the information will contribute to solving the problem can be answered once the problem has been analysed and clarified. To answer these questions requires that the objectives for data collection be stated and linked directly to the research problem. This is usually an iterative process as shown in Figure 1.1:

The following overview identifies and describes each stage of the study.

**Overview of the Study**

In order to describe this research project, this thesis has been designed around nine chapters that are illustrated in Figure 1.2. These chapters involved the identification of the elements needed to motivate and engage adult learners using an interactive multimedia program, a discussion of the development and implementation of such a program, an evaluation of the methods used to study the student outcomes of using the program, analyse and interpret the data from the study, and finally derive conclusions from the data analysis and make recommendations.
This study set out to identify what was required in order to motivate and engage adult learners when using an interactive multimedia program. A literature survey covering issues such as instructional design theory, andragogy, cognitive engagement, goal based learning, higher order theory and situated cognition was conducted. Higher order theory covers the related issues of thinking skills, reasoning, critical thought and problem solving. Although each of these are separate skills, they are often used interchangeably and confused with each other. Higher order theory also attempts to differentiate lower order and higher order thinking (Lewis & Smith, 1993).

The survey outlined in this thesis revealed themes such as the design of the content, the task and the media, including interactivity, presentation and control. Out of this literature survey the eight learner effects necessary for motivation and engagement were identified, and the program was then developed, taking into account as much of the theory gleaned from the literature as was possible, and an implementation and evaluation schedule completed.

Chapter 2 outlines the eight identified learner effects of an educational environment which have the potential to motivate and engage students. These eight attributes formed the basis of the interview questions, but other themes also emerged in the data.
analysis, such as navigation, learning outcomes and direct visualisation. Keller’s (1988) ARCS model emerged very clearly in the students responses to questions, but these responses were woven back in to fit into the eight original attributes.

Motivation is traditionally a difficult concept to measure as it is an intervening variable, coming between the stimulus and the response and linking the two together. Motivation is also a temporary variable, when present a behaviour is performed, when motivation is absent the behaviour is absent and therefore difficult to measure (Petri, 1981). This can be contrasted with learning where the behaviour change is usually more permanent and usually more easily measured.

Chapters 3 and 4 describe the process of designing, evaluating and implementing a multimedia microworld with the eight motivational learner effects. In an attempt to measure whether the eight learner effects had the desired impact, students were investigated in various ways, both during their use of the program and in a follow-up interview. Chapter 5 covers in more detail, the determination of information needed, data collection methods, and their assembly into useable information. The results of this study are detailed in chapters 6, 7 and 8.

Chapter 9 then gives an overview of the study, together with a summary of each of the results of the research questions. The implications of the study are then reviewed, with limitations and suggestions for further research being given.
Chapter Two

Literature Review

This chapter describes the development of a framework upon which the design of an instructional interactive multimedia program for adults could be based. In order to accommodate the needs of this particular group, current research on andragogy, cognitive engagement, learning theory, higher order thinking, goal-based learning and situated cognition are reviewed. A taxonomy of factors that engage learners with educational multimedia are explored, particularly as they relate to motivation and engagement. These include content issues such as gaming, individual and cultural differences, and attributes of motivation; task issues, such as attributes of learning environments and learning outcomes; and media issues, such as interactivity, presentation, and control.

The chapter concludes with a summary of the extant literature as it relates to the development of a multimedia program designed to motivate and engage adult learners and provide a framework for the research questions explored in this thesis.

Interactive Multimedia

As demands on university educators change, increasing attention is turning towards teaching with technology and the attendant philosophies and practices that go with such teaching. Issues such as the ways in which educators can ensure initial and ongoing motivation of the students, the engagement of their interest during the learning process, accommodating the whole gamut of individual differences, and the design of the actual learning programs to be used, are all occupying the time and attention of learning theorists and university academics everywhere.

Of all the instructional media available to educators, it is interactive multimedia (IMM) which has most recently captured the attention of instructional designers, teachers and product developers. Some of the reasons for this are that IMM seems to have the ability to reduce contact time between the instructor and class (Dempsey, Rasmussen & Lucassen, 1996), it is purported to be able to improve practical reasoning skills (Wood, 1987), and to provide education for mass audiences no matter where they are located. It is predicted that by the year 2000 computers will be
Chapter 2

Review of the Literature

utilised in some form in more than half of education and training delivery (Harrington, McElroy & Morrow, 1990). One problem facing adult users of IMM though, is that while there is a high degree of development of educational multimedia overall, the majority of the creative energy and money expended on IMM development is directed towards children’s “edutainment” and ignores the special needs of adult learners. There is a tendency currently, for interactive multimedia to be developed without a sound instructional design model or theoretical framework, leading to existing materials having multimedia elements added rather than being completing redesigned (Herrington, 1998; Stoney & Oliver, 1997).

Interactive multimedia (IMM) can be defined as a type of electronic program in which the user is a participant in the activity rather than a passive observer (Morrison & Morrison, 1994). Barker (1994) in Sims (1995) defines interactivity in learning as “a necessary and fundamental mechanism for knowledge acquisition and the development of both cognitive and physical skills”. True interactivity is determined when the user feels him or herself to be participating in the activity—in other words, when the senses are engaged in the action (Laurel, 1993).

Early IMM used a stimulus/response approach whereby challenges were set and incentives or rewards were offered. Early users of this approach were video games, but IMM has moved on to incorporate education and entertainment—often known as edutainment. Today, many of the designers and producers of IMM are from the theatre arts industry, reflecting this trend towards entertaining educational software. As Sims (1995) states, “The implementation of interactivity can be perceived as an art because it requires a comprehensive range of skills, including an understanding of the learner, an appreciation of software engineering capabilities, the importance of rigorous instructional design and the application of appropriate graphical interfaces. If we are to be recognised as developers with professional capabilities, as competent practitioners, then it is critical to understand what makes an application interactive, instructional and effective.” (p. 1). This, then, brings together the educator, the software designer, as well as the content expert.

Multimedia itself "encompasses a range of data types, including analog and digital video, two-dimensional and 3-D animation, audio, and even hyperlinks and digital ink. It also includes delivery media, such as CD-ROM discs and drives, graphics
display hardware and sound cards. Specialised hardware devices, such as digital signal processors (DSPs) for speech and signal processing, are starting to appear in desktop systems and will play an increasing role in learning systems” (Reinhart, 1995, p 58). Edutainment software is now one of the fastest growing segments of the entire personal computer software market and as such, it must be driven by sound instructional design theory.

The Philips Corporation recognised that adults wanted to have an interactive experience for learning when they introduced their interactive multimedia with titles such as *Luciano Pavarotti* and *The Great Impressionists of the 20th Century*. However, there is still a paucity of programs that have been designed thoughtfully and carefully to accommodate not only the multimedia elements, such as sound, video, high quality graphics and an intuitive user interface, but which also stimulate or engage the emotions of the learner, as well as focusing on cognitive aspects.

The notion of engaging not only the cognitive domain of learners, but also the affective domain is not new. Vygotsky recognised its importance when he stated:

> The separation of the intellectual side of our consciousness from its affective, volitional side is one of the fundamental flaws of all of traditional psychology. Because of it thinking is inevitably transformed into an autonomous flow of thoughts thinking themselves. It is separated from all the fullness of real life, from the living motives, interests, and attractions of the thinking human. (as cited in Wertsch, 1985)

In spite of this thinking, Vygotsky's work did not begin to examine the importance of affect until close to his death, however “his approach to affect clearly was concerned with how it provides the integrating and motivational forces for consciousness” (Wertsch, 1985, p 189).

In order to apply this view to designing IMM programs, it is important that a taxonomy of factors that engage learners with multimedia is developed—an understanding of basic instructional design theory, how engagement of the affective domain of adult learners may be achieved, how individual and cultural differences can be accommodated, the various elements of motivation, the various types of media that can be used and finally what type of tasks may be supported.
One taxonomy that engages learners with educational multimedia has been suggested by Jacques, Preece & Carey (1995). They combine content, media and task to enhance motivation and engagement, as exemplified by Figure 2.1.

Figure 2.1. A taxonomy of the factors that engage learners with educational multimedia (modified from Jacques, Preece & Carey, 1995, p 57)

There are many instructional design theories beginning to emerge for educational multimedia, but the taxonomy represented in Figure 2.1 addresses the issues of motivation and engagement—with the content, the media and the task, as well as suggesting a framework for studying learning theory.

Historically, educational psychology has focussed on cognition, and was dominated by behaviourists such as Skinner, who, as cited in (Goleman, 1996) “… felt that only behaviour that could be seen objectively, from the outside, could be studied with scientific accuracy” (p 40). The behaviourists thus ruled the affective domain out of bounds for science. In the 1960s the cognitive revolution looked at learning and the nature of intelligence—still ignoring the part emotions played in learning, although it was widely known that the emotional centre of the brain influences the rest of the brain, including its centres for thought (Goleman, 1996). Goleman goes on to state that “…this cognitive model is an impoverished view of the mind” (p 41). In the 1990s, psychology finally began to recognise the essential role that feeling played in thinking and credence was given to the concepts of motivation and engagement.
The concepts of motivation and engagement are not easy to define nor is the problem of integrating them into computer-based learning easy to solve. The educational theorists and psychologists have, over the years, embraced various theories of motivating and engaging students, from Skinner’s theory of reinforcement and reward to Maslow’s hierarchy of needs (Maslow, 1970; Skinner, 1968). Motivation has been defined as “… the word used to describe those processes that can (a) arouse and instigate behaviour, (b) give direction or purpose to behaviour, (c) continue to allow behaviour to persist and (d) lead to choosing or preferring a particular behaviour” (Wlodkowski, 1982). Viewed from a quantitative perspective, motivation is associated with drive, concentration, energy and intensity of behaviour and can be operationalised as time on task or engagement (Ames, 1987). “Enhanced” motivation is assumed when learners spend long periods of time engaged in an activity.

The qualitative approach to motivation is concerned with the content and direction of the students’ cognitive processes, focusing on ways of modifying or changing the way students think (Ames, 1987). Qualitative enhancement of motivation is to do with encouraging students to adopt goals, process information differently and to attend to specific types of information (Ames, 1987). Promotion of personal competence and specific metacognitive processes help students develop the ability to initiate, direct and maintain their own learning (Wittrock, 1984). Unlike quantitative motivation, qualitative motivation is not seen as a covariant of achievement, but rather a desirable commodity in its own right (Ames, 1987). Ames goes on to point out that to achieve qualitative motivation, the classroom structure must be altered to accommodate motivation enhancement (p 125).

Eliminating social competition may be one way of enhancing qualitative motivation. According to Ames (1987) competitive goal structures do not promote positive self-worth, continuing motivation or quality task engagement. A learning program which allows students to compete only against themselves or with a virtual entity (eg. a computer), will overcome the negative motivational effects of competition. One of the advantages of self-paced, self-regulated, independent learning is that errors become an acceptable part of the learning strategy and if there is no penalty for making errors, students are more likely to learn from their mistakes and are more likely to undertake challenging tasks (eg. Ames, 1987, Norman, 1994).
While it is difficult to directly link motivation with learning, a study by Uguroglu and Walberg (1979) cited in Wlodkowski (1982) found a highly consistent positive correlation between motivation and achievement. Although motivation is just one variable linked with achievement, it has been found to be a necessary condition for learning and without it, the best designed multimedia based instruction may be wasted (Wlodkowski, 1982). Continuing motivation is associated with feelings of competence, self-efficacy, perceptions of personal control, relevance and stimulation of curiosity (Kinzie, 1990). A review of the literature has identified a paucity of research examining the place of motivation and engagement in instructional multimedia, and in particular continuing motivation.

Multimedia developers are beginning to struggle with the notion of developing an interactive learning environment which combines the psychological and philosophical underpinnings of learning theory, with the need to fulfil prescribed educational requirements (Hannafin & Rieber, 1989). A focus of the research being done is interactivity, which is seen as an essential component of effective IMM. As Rieber (1996) points out “it is surprising that one of the most fundamental and important concepts of human interaction has received so little attention by our field—play” (p 43). Rieber theorises that this is perhaps because play is not a serious part of scholarship, that it has an “easy” connotation and that adults generally don’t think of themselves as “playing”.

Play is an important part of learning—both formal and informal (Rieber, 1996; Glickman, 1984; Kafai, 1992; Piaget, 1952; Yawkey & Pellegrini, 1984; Caillous, 1961), but currently play, fun, humour and enjoyment are words synonymous with computer games played by all ages. However, they are not words which readily spring to mind when using educational multimedia packages. Play, or a version of it, should be an inherent part of the design of an IMM package, and has been found to be a powerful construct for interpreting meaningful learning (Rieber, 1996; Csikszentmihalyi, 1990).

Playing is described by (Csikszentmihalyi, 1992) as a flow activity—where total immersion takes place and self-consciousness and time disappear, and where the experience is so gratifying that people will undertake it for its own sake. Learners concentrate best when pushed to give a little more than usual—asked to give too little and they will be bored, asked to give too much and they will get anxious,
particularly if assessment is involved. However, many adults enjoy the stimulation of a very difficult challenge which is evidenced by their participation in activities such as acrostics and cryptograms, and will push themselves to meet a stimulating challenge if it is presented in a non-threatening environment (i.e., where no assessment is involved (cf. Caillois, 1961). Goleman (1996) states that "...flow occurs in that delicate zone between boredom and anxiety" (p 92). This could be questioned as a definitive statement; the zone between boredom and anxiety, rather than being delicate, could be quite variable depending on the task and the participants. However, it is quite likely that flow will occur more readily if the learners have the added stimulation of a challenge that is slightly beyond their comfort zones, where they have to push themselves a little harder than usual (Csikszentmihalyi, 1992). Combine the flow activity with educational tasks and improved learning outcomes should follow (e.g., Quinn, 1997). Games are one means of achieving this convergence of learning with enjoyment, but games can be hard to define and to conceptualise and debate has raged in various fora as to what specifically constitutes a game (cf., IT-Forum, Psygames listserves). As Quinn asks "...when does a flight simulator change from a training tool to an entertainment activity?" (1997, p 1).

**Framework for studying learning theory**

It is useful to restate the salient parts of contemporary learning theory as it applies to computer based environments and instructional multimedia. Designing for learning in such environments should include a motivational plan as well as an awareness of the needs, wants and individual differences of adult learners. The literature divides itself into sections which form the framework for studying these issues as suggested in Figure 2.2. This framework is based on the taxonomy by Jacques, Preece & Carey (1995), but has been extended to incorporate other issues of instructional design theory, such as andragogy, learning theory, higher order thinking, goal based learning, cognitive engagement and situated cognition, all of which will be discussed in this chapter.
Andragogy

The last three decades have seen the development of theories of adult learning theory—andragogy, which is defined by Knowles (1980) as “the art and science of helping adults learn” (p 43)—as well as pedagogy, due to the fact that a growing number of researchers feel that adults have different needs from children (Cross, 1981; Fassig, 1994; Knowles, 1978; Knowles, 1980; Zemke & Zemke, 1988). There is an emerging body of theory which suggests that the adult curriculum should be built around the students' needs, that we need to focus on the convergence of technology with the way adults learn, including matching instruction to individual differences, multiple intelligences, higher order thinking skills and dominant senses (Fassig, 1994; Knowles, 1978; Thornburg, 1991). Adults want to set their own learning pace, use their own learning style, keep their learning flexible and easy to change, and put their own structure on a project (Tough, 1978), although this has proven, in many cases, to be difficult to do within a fixed course structure. Minimalist theory provides a framework for the design of learning with computers (Carroll, 1990). The theory suggests that learning tasks should be meaningful and self-contained; realistic projects should be set as early as possible; instruction should allow self-directed reasoning and improvisation by increasing the number of active learning activities;
and there should be close links between the theoretical and real worlds (Carroll, 1990). In the normal mainstream university class, where information is often delivered in a transmissive fashion, these elements are not easy to achieve. There is, therefore, a drive to change the ways in which information and knowledge are acquired, involving, not only a change in content, but also methods and resources. A rethinking of assessment is also necessary, making it more authentic and realistic to the learners. Assessment strategies should examine the content that has been learned, the strategies employed in the learning and what can be achieved with the new knowledge (Grabinger, 1996).

There are many lessons for IMM development to be formed by the study of andragogy—learning must be developed around learners' needs, rather than being teacher or subject centred. As stated earlier, adult learners are self-directed, bring a wealth of experience to the learning task, are problem or goal centred rather than task centred, and need to be ready to learn the content in question (Knowles, 1980).

Adults also have a strong need for feedback, both for recognition of work well done and guidance when improvement is required. A self-paced resource based style of learning has the possibility of providing the learners with the means to track their own progress, so that they can reassure themselves as to their improvement.

Another of the elements necessary to motivate and engage adult learners is active mental participation (Watson, 1969). This entails a level of experimentation with a learning activity that is inferential and entails elements of discovery learning, as well as promoting cognitive engagement.

**Cognitive Engagement**

One of the essences of andragogy is considered to be the concept of self-regulated learning, which is the highest form of cognitive engagement (Corno & Mandinach, 1983). There are three main, but distinct, components of self-regulated learning: (a) the learners choose to learn and plan and manage their own learning; (b) a means of organising the instruction which gives the learners a high degree of personal control needs to be provided; and (c) there must be a means of giving the learners a high degree of personal autonomy (Caffarella, 1993). The learners will therefore be responsible for what they learn, when they learn and how they learn.
In order for self-regulated learning to be truly efficacious, students should set their own learning objectives and then evaluate their learning in terms of their own objectives. Self-regulated learning is seen as critical to the commencement and continuance of motivation in adult learners, and consists of specific cognitive activities (Corno & Mandinach, 1983). Figure 2.2 shows a model of motivated learning and cognitive engagement based on Corno & Mandinach, (1983). The model assumes that learners come to the learning task with prior knowledge and experience. These act in consonance with features of the instruction to determine the amount and kind of cognitive engagement a student will exhibit on a particular task. Effective cognitive engagement will include careful attention to specific information; analysis of item features, visualisation, ability to filter out items less likely to be correct.

Learners who are less effective are unable to sift the relevant from irrelevant information, hesitate in making selections thus slowing down response time, and show unwillingness to guess when unsure (Corno & Mandinach, 1983). Effective learning skills then, involve selectivity, relating new information to past knowledge, and task-specific planning. Corno and Mandinach (1983) developed a model that emphasises the importance of self regulation processes to the learning-motivation cycle. The model accommodates the fact that adult learners come to the learning task with past experience, skills and knowledge upon which to draw. This background has an impact on the way in which they approach the task, their expectations of success leading to feelings of self-efficacy, their planning and strategies for accomplishing the task, self-monitoring of performance, and then the replication of these activities for the following tasks. The fact that students are able to select their tasks, set their own goals and receive guided modelling increases levels of motivation and engagement.
Figure 2.3 highlights the fact that motivation and cognitive engagement are intermeshed and if these elements are built in to the learning program, students will be able to apply different strategies to their learning. Due to the fact that students will be able to vary the difficulty of tasks, tasks will have a novelty aspect, there will be different types of information provided, there will be elements of scaffolding and coaching, and students will be able to apply old understandings to the new information, incorporate elements of their experience, set their own goals and monitoring will be appropriate and on demand.

Other researchers (e.g., Lepper & Hodell, 1989) have found that motivation not only enhances learning outcomes, but also increases subsequent learning and retention. Lepper & Hodell (1989) also found that with motivation there was evidence of learning which extended beyond the original tasks called for in the activity and students were able to generalise to new learning.

The task, then, is to design a form of teaching and learning that incorporates these features. Multimedia may provide some of the answers; it is a powerful and popular medium with the capacity to allow the learners to construct their own framework of knowledge. Many multimedia programs which require passive viewing are inadequate, particularly as higher order learning is usually a goal. There is a need to
know how it can be used to engage and motivate the adult learner (e.g. Greenberger, 1990; Wlodkowski, 1985).

Multimedia programs come in a variety of formats and the literature (e.g. Hedberg & Harper, 1996) suggests that there are three critical and related elements which need to be considered when discussing adult motivation as shown in Figure 2.4.

![Figure 2.4. A framework of effective interactive multimedia learning environments](image)

This model depicts the three elements of learning theory, individual differences and instructional landscapes, as interdependent upon each other if they are to be effective. When the three elements are combined successfully, they each contribute something unique to the motivation of the student.

**Learning theory**

Learning theory covers a wide range of activities, one of the most popular today is social constructivism (Duffy & Jonassen, 1992). Social constructivism is a useful model as the student takes part in relevant, realistic activities to which they can apply real world knowledge and understanding. In the social constructivist setting, communication is the main focus as this best reflects the macroworld of the students (Resnick, 1988). In this framework, the learning theory refers to the research on andragogy, situated learning, authentic activity, anchored instruction, goal-based learning, collaboration, reflection and guided discovery. These are all elements of "Natural learning theory" which is heavily based on experiential learning (Schank & Cleary, 1994). The natural learning process is organised in three stages sequentially arranged like a waterfall, as shown in Figure 2.5:
Chapter 2

Adopt a goal

Generate a question

Develop an answer

Figure 2.5. The learning waterfall (Shank & Cleary, 1994)

Natural learning sets the stage for students to learn in a context that is relevant to themselves and their personal goals, and it allows them to explore solutions to problems, sometimes failing, which causes them to generate questions, leading to further exploration of the issues. Natural learning is desirable as it draws on the experiences of the student, and relies on the student reflecting on these experiences and then formulating conclusions, going from the specific to the general. The process of reflection creates indices in the memory and these tie the experiences to each other and to the generalisations. New experiences which do not fit the generalisations create exceptions resulting in “rich” generalisations. These rich generalisations keep students mindful of relevant materials and help them achieve their learning goals (Schank & Cleary, 1994). von Wright (1992) uses four stages; first, doing and experiencing; second, reflecting on experiences—what was learned and felt; third, conceptualisation of the new insights and shaping a more adequate conception of the matter in question; and fourth, trying out the revised theory and looking for new feedback (p 65). Both these methods described above fit very neatly into the concept of situated learning which encourages reflection as the knowledge is in part a product of the activity, context and culture in which it is learned and used” (Brown, 1989). Learning environments should be, ideally, similar to the environments in which students are going to utilise the knowledge and skills, and it is therefore important to provide a learning environment which supports this learning waterfall and allows students to pursue goals which interest them. In other words “goals must underlie education” (Schank & Cleary, 1994, p2).
**Higher Order thinking**

The ultimate goal of contemporary learning is to promote higher order thinking skills. The whole notion of higher order thinking resists definition, and whilst most academic institutions will have the acquisition of higher order thinking as a goal, most fail miserably in their mission (Resnick, 1987a).

It is useful to identify some of the components of higher order thinking in order to attempt to integrate them into the design of instruction. As Glaser notes, higher order thinking is complex and comprises a number of facets, notably critical thinking, problem solving and reasoning (Glaser, 1984). Other authors discuss the interrelationships between rules, strategies, schema, heuristics and systems and describe these as “sameness” (e.g., Carnine, 1991; Glaser, 1984; Grossen, 1991). The concept of sameness can be used to teach a broad spectrum of students to solve problems and also to transfer information from one situation to another. Indeed, it is sameness which allows the brain to extrapolate rules from one situation and apply them to another. Carnine (1991) goes as far as stating that the value of sameness in expert problem solving is more important than a repertoire of metacognitive strategies.

An important part of developing higher order thinking skills is the ability to reflect upon the learning experience and incorporate the new knowledge with the pre-existing knowledge. The importance of reflection is well documented (Laurillard, 1995; Marsick & Watkins, 1991; Merriam, 1993). It is rarely supported due to the fact that it is internal to the learner and therefore nebulous to the teacher (Laurillard, 1995). The teacher oriented lesson provides the least amount of time for reflection by the learner, but multimedia, due to its self-paced, resource-based, independent learning is capable of promoting the links between experiential and conceptual knowledge. Building in a variety of scenarios upon which the student can ponder when making choices can bring about changes in understanding and give the learner confidence in that understanding. In order to learn and improve, reflection upon the performance is essential so that the learner knows what to keep and what to change (Norman, 1994). He goes on to say that employing a coach is the most efficient way of doing this and that self-reflection is more difficult. Children in video arcades are a prime example of the benefits of coaching, when the performance is improved by
collaborative reflection by peers. This group reflection also makes the whole experience more enjoyable and therefore more motivating.

In traditional teaching the emphasis is on the acquisition of lower level skills prior to higher level understanding, in many cases leading students to misunderstand the goals. Much instructional design is undertaken in the belief that until lower level skills are mastered, students will not be able to acquire higher level skills, or that higher level skills will automatically emerge from mastery of basic skills (Campione, 1996). In fact, there is a case to be made for higher order and lower order skills to be taught concomitantly, students mastering both level of skills as they apply their learning, rather than learning the skills, practicing and then application. Resnick (1987a) is one such researcher who argues that the acquisition of such skills is not necessarily hierarchical and that whilst lower order skills are being acquired, higher order processes can be developed conjunctionally.

Murphy (1991) highlights this contrast between the traditional classroom that teaches skills, leading to application; with the learner-active classroom where students have to learn the skills in order to complete the task, learning higher order and lower order skills concomitantly (Figure 2.6).

![Figure 2.6](image.png)

**Figure 2.6.** Contrasting the traditional with learner active teaching (from Murphy, 1991).

In other words, rather than learning skills in isolation and then re-learning their application to real world tasks, a learner-active approach encourages the application of problem-solving in context, and this application aids in the acquisition of skills, giving the students a reason to learn and helping them learn how to learn (Murphy, 1991).
Higher order thinking is characterised by problem-solving—but passive or immature learners are often poor at this, instead organising their mental activities around topics rather than goals, failing to connect their activities to anything in real life, focusing on surface features of the topic instead of examining it in depth, working until the task is completed, rather than taking time to reflect on the task, making subtle improvements, and learning in an additive way, rather than transforming their existing knowledge structures (Grabinger, 1996). When learners become purposeful, effortful, self-regulated, and actively engaged in a task they begin to take part in what Palinscar and Klenk (1992) term “intentional learning” which, they hypothesise, facilitates lifelong learning. The main skills required for intentional learning are questioning, self-reflection and metacognition (Grabinger, 1996), and these are described in more detail below.

**Questioning**

Questioning is an essential component of higher order thinking and leads to intentional learning (Scardamalia & Bereiter, 1991). In the traditional classroom the teacher asks the questions which provides a means of assisting performance—students will activate mental and verbal responses, allowing the teacher to regulate what the students are learning and understand what they are thinking (Gallimore & Tharp, 1990) but the students do not learn to frame questions based on their needs or an analysis of the problems at hand (Grabinger, 1996). Gallimore & Tharp (1990) describe the type of instructor-led questions that promote higher order thinking as “assistance questions” which produce a level of thinking that students would not achieve alone.

A learning environment needs to provide two types of questions—the “assessment question” which discovers the students’ abilities to perform the activity by themselves, and the “assistance questions” to prompt a higher level of thinking, thereby taking the students beyond their zone of proximal development (Vygotsky, 1978). The zone of proximal development is the distance between the actual development and the level of potential development when collaborating with more capable peers. The learning environment therefore should give students the opportunity to both respond to assistance questions and to ask questions—of the environment, or of their collaborator/s. If students are provided with such a learning environment where they are given the opportunity to ask questions to
guide their knowledge building, they are more likely to accept ownership of their learning, leading to them taking more control of their whole learning experience. This, in turn, enables them to find more relevance and meaning for what they are learning leading to lifelong learning skills.

**Self-Reflection**

Self-reflection is also an important component of intentional learning. “Self-reflection implies observing and putting an interpretation on one’s own actions, for instance, considering one’s own intentions and motives as objects of thought” (von Wright, 1992, p 61). Self-reflection involves the learners abstracting meaning and can lead to the understanding of reality in alternative ways. Self-reflection encourages students to think about the task at hand, comparing it with other activities leading to them thinking about implications and consequences of actions. Dewey (as cited in Goodman & Goodman, 1990) sums up this notion when he says:

*Thinking enables us to direct our own activities with foresight and to plan according to ends-in-view, or purposes of which we are aware (p. 238).*

Self-reflection, then, also involves the students thinking about how they approach a task and how to improve their performance, a level of self-reflection that involves metacognition.

**Metacognition**

Metacognition occurs when students think about what they are learning and is described by von Wright (1992) when he states: “Metacognitive skills refer to the steps that people take to regulate and modify the progress of their cognitive activity: to learn such skills is to acquire procedures which regulate cognitive processes” (p 64). When students use metacognitive skills they take control of their learning and planning strategies, monitor their own progress, make corrections and alter their learning behaviours and strategies when necessary (Grabinger, 1996).

Biggs & Moore (1992) show that the application of metacognitive strategies can increase higher order thinking and ultimately increase the likelihood of on-going motivation and lifelong learning.
As stated earlier, these three skills lead to intentional learning connected to real-life applications. Students become more reflective and their cognitive activities are goal-based, rather than subject oriented.

**Goal-based learning**

The needs and wants of students are often diametrically opposed to what the instructional designer has determined about their needs and wants (Grabinger, 1996). One method of overcoming this problem is to use goal-based learning which is skill-centred and learner guided. The instructional designer must design an environment that will create student interest and will facilitate their learning. A goal-based scenario is composed of a number of elements as defined by Schank & Cleary (1994) and illustrated in Figure 2.6 below:

![Diagram of Goal-Based Scenario](image)

The advantage of a GBS is that it accommodates both the needs and wants of the students and the desires of the course designers. It offers a chance for the students to pursue a clearly stated, relevant and interesting goal, and gives the course designer the opportunity to present a parcel of skills that the students need to acquire. The challenge is to design a course that creates student interest and gives them the opportunity to acquire the skills as they attempt to accomplish the motivating goals of the course. As Schank & Cleary (1994) state “as long as the goal is of interest to the student, and the skills needed to accomplish that goal are the skills the course designer wants students to have, we have a match, and thus a workable GBS” (p. 6).
Designers begin with identifying these target skills and then designing the course so that the students achieve acquisition of them—they tend to take a top down approach. Students, on the other hand, use a bottom up approach—they look at the context and structure of the activities of the program to motivate them to use it (Schank & Cleary, 1994).

At a very general level, people differ in their tendency to engage in and enjoy effortful cognitive endeavours, what is known in psychology as the need for cognition. Individual differences are at play in this realm (Duchastel, 1996). Theories on individual differences generally look at gender, age, cultural context and learning styles, although individual differences will also involve prior learning and experience, in fact any aspect to do with the learner. Instructional Multimedia are sometimes called instructional landscapes (Hedberg & Harper, 1996). Elements of instructional landscapes are their interactivity and degree of learner control, and their entertainment, experiential and motivational features. The instructional multimedia or landscape should have several features carefully woven through, including all the learner support and ergonomic elements which make it easy for the learner to use. Instructional landscapes are the ideal vehicle by which to “transport” the learner to practise in authentic environments which closely resemble real-world contexts and situated cognition is an ideal approach to use to accomplish this task (Hedberg & Harper, 1996).

Situated Cognition

Modern andragogical theory has an association between learning and experience. Schön (1983) theorised that learning and knowing are a function of people acting in the setting in which the knowing and learning are produced, which accounts for the situated nature of adult cognition. Situated cognition ties together knowing and doing, whereas 20th century western education separates the knowing from the situations in which it is used (Brown, 1988). This traditional view is deeply ingrained in most western education systems with teachers imparting knowledge in a classroom setting, rather than learners acquiring knowledge in a real world setting. Lave (1988) argues that learning is usually a function of activity, context and culture and this builds on Vygotsky’s theoretical framework which interlinks cognition and social interaction (Vygotsky, 1978). Both Vygotsky and Lave point out that social interaction is a critical component of learning, and Lave argues that it is an essential
part of situated cognition. Social interaction gives students greater breadth in which
to deal with their problems. It is well recognised that informal story-swapping often
provides more information than formal classroom lectures because learners hear
about problems and how to solve them (Nonaka, 1994).

Situated cognition examines the learning that occurs in everyday events and settings
and has four interrelated aspects—(a) authentic activity; (b) transfer; (c) social
interaction; (d) use of prior knowledge (Lave, 1991). Learning should be an all
encompassing activity, where the people, equipment, tasks and environment
interact, and in the process the learner becomes engaged via participation,
responsibility and ownership (Lave, 1988, Lave & Wenger, 1991). Lave (1988) also
argues that students should not just be given verbal or written directions and
explanations, but should actually be expected to carry out the tasks. The physical
context can be a critical component of learning and is frequently overlooked (Tyre,
1997). Students will behave differently in different physical contexts and it is the
setting which causes students to change the way they think and act. The setting can
also help students define and solve specific problems (Lave, 1988).

Situated cognition, therefore, gives learning a context similar to that of the real world
and subsequently provides an authenticity to learning. This is tied closely to the
theories of adult learning where Knowles (1980) made his claim that adults learn in
the most meaningful way when the learning is anchored to their everyday lives.
Jarvis (1987) argued that learning is intimately related to the world and is affected by
it. This means that adult education must be firmly located in an authentic activity
where it can be based on cognitive practices rather than decontextualised processes
and principles (Wilson, 1993). It should be noted however, that learning styles
impact on the effectiveness of situated learning. There are learners who would rather
read a book than complete a case study or explore a piece of multimedia, and there
needs to be ways of identifying and accommodating this type of learner, rather than
force all learners to learn in the same way. In other words, learning needs to be
anchored in an authentic activity, but the activity must be able to accommodate
different learning styles.

A word of caution for situated cognition is framed by Merriam (1993) who counsels
that there are several problems with the attempts to locate learning and knowing in
experience. In the theory of situated cognition, learning and knowing do not exist
independently of the activity, and Merriam believes that situated learning has neglected the structuring effect of activity on cognition, and that the actual nature of experience and activity and their effect on cognition is not enough (p 76). This view is reinforced by Laurillard (1993) who asserts that knowledge has to be abstracted in order to become generalisable to other situations. This generalising of knowledge to new situations, where the learner can use knowledge in more than one setting, is rare and unpredictable (Lave, 1991) and relies on the student being able to abstract the information from the past and apply it to present circumstances and then to future situations. It has been argued that contextualised learning is much more likely to promote transfer and Laurillard (1993) and Merriam (1993) also raise the question of how learning can be resituated so that it regains its meaningfulness. Merriam suggests that the answer may lie in authentic activity. Herrington & Oliver (1995) suggest that two of nine critical characteristics of situated learning for instructional design involve authentic context (an activity which reflects the way the knowledge will be used in real life (Herrington & Oliver, 1995:p. 256) and authentic activity.

There is a wealth of evidence on the way adults learn which suggests that the principles of situated learning do provide some of the answers if they are properly constructed (eg. Fassig, 1994; Galbraith, 1991; Knowles, 1980; Merriam, 1993; Robinson, 1992; Zemke & Zemke, 1995). The traditional method of teaching adults in a decontextualised fashion needs to be reconsidered and as Merriam (1993) states “if learning and knowing are to be based on the actual cognitive practices of humans, then they have to be located in authentic activity”.

Authentic activity is culture specific and is a useful mechanism for imparting a value system and goals of a society (Brown, 1988). Authentic activity, therefore, is ideal for teaching about business systems, as a business culture may differ from a societal or school—the goals and values may be somewhat at variance. Indeed, Brown, et al., (1988) claim that what students do in school tends to be an “ersatz” activity which distorts both the knowledge the culture to which it is attributed and performance requirements within the school culture bears little relationship with the performance requirements of the outside world (p. 9).

Merriam (1993) and Resnick (1987b) contrast the use of authentic activity with the traditional simulated processes used in schools and universities. Authentic activity demands that learning is located in the actual situations, with problem solving and
cognitive practices carried out in conjunction with the setting (Wilson, 1993). This has led a number of authors to explore the notion of apprenticeship learning where the learning takes place in situ—or in the case of a formal learning environment, the situation is simulated and integrated with the learning tools and social interactions (e.g. Brown, et al., 1989; Cognition & Technology Group at Vanderbilt, 1990; Collins, 1991; Resnick, 1987b; Wilson, 1993; Winn, 1993).

A key characteristic of authentic activity is that the tasks are ill-defined with the students having to find as well as solve the problems (Herrington & Oliver, 1995). Whilst the problems can be anchored in the real world, the multimedia program often packages up the answer in a way that the student can solve the problem without moving from the computer, when the problems encountered in the real world are not so neatly solved (Herrington & Oliver, 1995). A program which can combine the relevant with irrelevant material may more closely reflect situations likely to be encountered by students.

Brown, et al (1989) have tied together the importance of locating cognition in authentic activities through an apprenticeship approach that situates learning in a social, tool-dependent and interactive context. Instead of presenting information in its present decontextualised fashion, the situated view proposes modeling, coaching and practice approaches (Schön, 1983).

Cognitive apprenticeships provide a general framework with four components—content (domain knowledge and learning strategies), methods (modelling, coaching, scaffolding, fading, articulation, reflection and exploration), sequences (increasing complexity and diversity) and social aspects (expert practice, intrinsic motivation, cooperation and competition) (Brown, 1989). In a cognitive apprenticeship situation, students move through various levels of skill building and knowledge acquisition to a degree of expertise. In this way, the learners are provided with modelling and scaffolding and as they become more self-confident and in control, they move to collaborative learning and participate consciously in the activity or culture. Collaboration leads to articulation and reflection which in turn fosters generalisable knowledge, grounded in the student's situated understanding (Brown, 1988). The process continues back and forth through continuing authentic activity as students acquire, develop and use the conceptual tools and eventually they become "practitioners". (Brown, 1988) suggests that this progressive process suggests that
increasingly complex microworlds should be replaced by increasingly complex enculturating environments.

A cognitive apprenticeship approach to teaching and learning is particularly appropriate for adults as the latter stages rely on self-directed learning (Le Grand Brandt, 1993). This type of learning experience helps the students organise their thought processes while handling difficult tasks and problem solving. Cognitive apprenticeships provide access to knowledge which cannot be gained in more traditional settings—knowledge normally held tacitly about how to perform in the real world (Le Grand Brandt, 1993).

The Cognition & Technology Group at Vanderbilt (1990) have also explored the notion of anchored instruction as being closely related to that of authentic activity. If situated cognition provides the framework for learning through everyday experiences, anchored instruction provides the means for recreating those experiences in an educational setting (Cognition & Technology Group at Vanderbilt, 1990). A traditional area for anchored instruction has been the case study approach so commonly used in business studies courses. Students are provided with a scenario together with a set of problems and goals and they have to navigate through the problems to a solution. Interactive multimedia provides a new dimension for anchored instruction as it can provide a context in which the problems can reside and the students can navigate through it, solving the problems and meeting goals as they go. This can save a great deal of time for the instructor who usually has to "set the scene".

An advantage of multimedia is that it can incorporate elements that utilise the affective domain, such as music and video (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1993). In their studies, Bransford et al use video materials as "anchors" (macro-contexts) for all subsequent learning and instruction. As explained by the Cognition and Technology Group at Vanderbilt (CTGV) (1993, p52):

*The design of these anchors was quite different from the design of videos that were typically used in education...our goal was to create interesting, realistic contexts that encouraged the active construction of knowledge by learners. Our anchors were stories rather than lectures and were designed to*
be explored by students and teachers. The use of interactive technology makes it possible for students to easily explore the content.

Anchored instruction is closely related to the situated learning framework (see CTGV, 1990, 1993) and also to the cognitive flexibility theory (Spiro, Feltovich, Jacobson, & Coulson, 1992) in its emphasis on the use of technology-based learning. Anchored instruction is also credited with assisting in overcoming inert knowledge, which is the inability to transfer knowledge to real-life problem solving tasks. The major goal of anchored instruction is to enable students to identify the critical aspects of the problem-solving task and to understand the changes taking place as they view the situation from other perspectives (Bransford, et al., 1993). As Honebein, Duffy, & Fishman (1991) state, collaborative learning is one strategy useful for generating and evaluating alternative perspectives on learning. They go on to describe the way medical interns diagnose and evaluate medical problems in a group situation which gives multiple perspectives on the problem, thus allowing for alternative procedures or modification of existing procedures. This would not be possible without collaboration. Collaboration, therefore, is useful in allowing the students to verbalise and reflect upon their understandings and theories of the task in hand and this verbalisation leads to a deeper understanding of the material which in turn can lead to higher order thinking. When using anchored instruction, the anchor should be intrinsically interesting and should allow the students to abstract their problem solving to a variety of situations.

Although an advantage of multimedia is that it is flexible and allows students to work alone at their own pace, it is sometimes criticised as not allowing students to discuss their work. "...Interactions and activities need to be designed to engage higher-order thinking and critical reflection, rather than the rapid-fire question and answer format requiring only a low level factual response or selection." (Herrington & Oliver, 1995).

This can be achieved for the single user by constructing collaborative elements which don't involve a second person. The interaction of student and program is the same form of collaboration as between the student and tutor, but in order to achieve this the program should include elements of guided discovery (Laurillard, 1995). In this case the program guides, advises, comments on progress and offers
explanations—"...this becomes a vital role for integrated multimedia—to provide the guided discovery mode of learning that is otherwise so rare" (Laurillard, 1995).

Guided discovery is a natural consequence of situated learning and anchored instruction. It is the antithesis of the didactic learning approach so common in lecture situations, in that it does not present the learner with abstract rules to be learned, but with concrete examples to be understood (Boyle & Margetts, 1992). In a guided discovery approach students are introduced to problems and given a general framework for solving them. Traditionally, these events have been in a verbal or print-based format, but interactive multimedia and microworlds provide a rich opportunity to present both the problems and the framework to solve the problems. IMM can also provide video clips, sounds and animations which allow students to receive information in a variety of formats, some or most of which will be conducive to individual learning styles, which in turn facilitates comprehension. There is also an opportunity to provide strategies used by experts with which to compare student solutions, providing a means of feedback and reflection. The inclusion of expert performance allows the students to "observe an experienced practitioner at work" (Herrington & Oliver, 1995). This form of feedback, or authentic assessment, is most effective when it is in a meaningful context and relates to authentic concerns and problems faced by students (Brooks & Brooks cited in Holzer, 1994).

The above factors of situated cognition, anchored instruction, authentic contexts, self-paced learning, collaboration, guided discovery and expert performance all contribute to an increase in motivation by providing a learning environment which is meaningful and has a semblance of realism, but one of the most significant problems is how to synthesise motivational variables into a cohesive and realistic instructional design (Wlodkowski, 1982).

**Engagement**

Attention to the elements of instructional design theory as outlined above, will often lead to students' engagement, as the material is designed to be appropriate to the learner, it is relevant, goal based and promotes reflection and problem solving. In order to achieve a level of student engagement, a wide range of factors need to be accommodated. The design of a learning environment can have a large impact on the way in which students engage with the task, the accommodation of cultural and
individual differences can likewise be an important influence on the degree of engagement students feel when undertaking a learning task.

Engagement in a task is usually a positive experience for students, with some researchers reporting that students feel happiness and surprise during task engagement, ensuring that mastery is developed, leading to increases in task engagement. This cyclical activity is important to observe when trying to understand the role of emotions in motivation, task engagement and mastery development (Matsumoto & Sanders, 1988; Tomkins, 1970). Quinn (1997) posits that engagement is also related to embeddedness and interactivity and that these two elements complement good learning design.

Interactive multimedia instructional design is still in its formative stages and the interface design often used in the programs reflects this. It seems as though the inspiration for the design of many programs is derived from productivity software with buttons and menus being the main means of navigation. The effect of this is that the user hurries through the program in order to complete the task quickly and efficiently, with a resulting decline in engagement time. "... time lends itself to engagement, a new vector of quality enters into our "useability" equation... interfaces must simultaneously maximise the quality of time spent [and] reduce the complexity of the processes they must go through to be present there" (Gould, 1995).

The process of engagement leads to reflection which is too often neglected (Laurillard, 1995). If buttons and menus are eliminated or substantially removed from the multimedia program, the user will have to make decisions as to where to move next and how to explore the environment. This act of decision-making involves time (and therefore engagement) and a degree of reflection which cannot be emulated with software which has a productivity look and feel to it (Gould, 1995). If this technique is to be successful however, the interface should be intuitive and simple and students may have to be taught to explore if they have never used this type of program before. This type of interface also leads to the possibility of greater learner control—another major aim of adult learning theory.

Control

Learner control has been one of the most researched areas of computer based instruction, and is that aspect of design which allows the learners to choose the
paths, content, pace and nature of the feedback they receive (Reeves, 1993c). A crucial aspect of interactive learning is the way in which control is handled (Kinzie, 1990; La Follette, 1993). There are three basic issues for interactive learning: learner control, self-regulation of learning and ongoing motivation to learn (Kinzie, 1990). When control is given to the learner, adaptive instructional decisions can be made, whereas with system control, instructional decisions are made for the student. This interaction between the learner and the environment is important in determining the interactivity of the program. Learner control together with coaching is more effective than total learner control or browsing, as the learner is not always capable of maximising use of the control capabilities, even when the technology provides unlimited learner control, and therefore guided discovery is superior (Hannafin, 1992).

Proponents of learner control believe that it facilitates greater achievement, but Steinberg (1989) found that learner control could create better engagement and attitudes, but not necessarily greater achievement, and that not all students were motivated by being able to control their learning (Reeves, 1993c). This finding has been replicated by Murphy & Davidson (1991) who found that learners completed the tasks faster but did not have superior recall or retention of concepts. These findings would suggest that a balance between learner and system control may enhance learning whilst retaining the motivational effects of control; a microworld is capable of being programmed to accommodate different levels of learner control on a continuum from linear or system control, through guided discovery to a browsing mode. One such compromise is known as an advisement orientation, where the system makes suggestions to the learner which they can follow or ignore (Ross & Morrison, 1988).

Whilst learner control has the capacity to better engage the learner, it will only achieve this if the program appeals to the learner cognitively and affectively. There is a general belief that multimedia is more inherently entertaining than other forms of instruction, but this is not always the case. The multimedia program needs to be pitched at the level of the user to make it emotionally and viscerally appealing (Berlo, 1960; Low, Venkataraman, & Srivatsan, 1994). In order to make it emotionally appealing as well as useful instructionally, a microworld or discovery game could be used, based on a theme which is relevant to the information being imparted and to
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the learner (Cognition & Technology Group at Vanderbilt, 1990). The theme can be
situated in a real life context which allows transfer of theory to a variety of
situations. Students use the situation context to remember the theory rather than
memorising, without necessarily understanding, chunks of text. (Collins, 1991).
Whilst a learning environment such as a microworld should impart useful
knowledge, it is generally more effective in teaching principles, procedures and
concepts than facts (Low, et al., 1994; Bredemeier & Greenblat, 1981; Greenblat,
1973). In a business education environment, the microworld can present a view of
the business world not previously observed by the students such as ethical standards
and behaviours. This builds on the principles of higher order learning where
students can be guided into heuristic problem solving and logical thinking.

The environment should encourage teacher involvement to allow the user to explore
with adaptive advice. Exploration based on strict discovery has been shown to
produce a high degree of knowledge of the program but little learning. Exploration
with adaptive advice, either provided by the teacher or by an on-line help or guide
system promotes a high degree of content knowledge with a minimum of program
knowledge. (Borsook & Higginbotham-Wheat, 1991; Leutner, 1993). The issues of
how to design the program and then to integrate it into the teaching environment
thus becomes critical. It cannot simply replace the formal class, but must be
integrated into the instructional strategy with the teacher providing whatever
scaffolding is necessary in order for the students to use the program efficiently and
effectively.

The notion of humour, fun or play is an important element in keeping learners
motivated and engaged. Entertainment is one of the factors influencing motivation,
but a note of caution is sounded by (Baker, 1981) on using games or entertaining
instructional adjuncts as an incentive. He states that such adjuncts may serve as a
distraction and students try to finish the assigned task quickly so that they can
"play", thereby rewarding them for finishing quickly. Where an entertaining
educational adjunct is to be used it should be skilfully woven into the instructional
design so that it is an inherent part of the design rather than adjunct and contributes
positively to the learning outcomes (Baker, 1981). The design of the content of the
program, then, is an important facet in enhancing student engagement with the
program.
Content

Content that has the potential to be engaging must accommodate the individual and group needs of the students who are to use it, and consider the means by which initial and on-going motivation can be facilitated. One of the methods of engaging students is to turn the content into a type of game. Gaming has been accepted in educational circles in a minor way for a long time, but with the advent of IMM, the potential for incorporating games has grown enormously.

Gaming

A game is often described as "activities involving one or more players. It has goals, constraints, and consequences. A game is rule-guided and artificial in some respects. Finally, a game involves some aspect of a contest or a trial of skill or ability, even if that contest is with oneself" (Dempsey, 1997). The Macquarie dictionary says a game is "an amusement or pastime, a contest according to set rules, a match; a proceeding carried on according to set rules as in a game". Game theory says a game is any situation where you can define: a player or players (chance can be a disinterested player), a strategy for each player, and a payoff for each player which is a result of actions (including no action) of the players. The payoff can be a reward or punishment. A strategy is a rule or set of rules by which a player is selecting moves. A game also has "states." Each next state is determined by the collective moves or actions of the players (Redfield, 1997). Others have defined games as an activity which "...because of the way they are constructed, they help participants and spectators achieve an ordered state of mind that is highly enjoyable." (eg. Csikszentmihalyi 1992:p 72). In an attempt to define these pleasurable activities, Caillois (1961) divided them into four categories depending upon whether, in the games under consideration, the role of competition, chance, simulation or vertigo is dominant. These four categories were labelled agon, alea, mimicry, and ilinx and Caillois (1961) claims that they all belong to the domain of play. He defines Agon as games which are basically competitive; Alea are games of chance; Ilinx are games which alter consciousness by scrambling perception; and Mimicry are games in which alternative realities are created, for example, theatre. Csikszentmihalyi (1992) points out that these four classes allow participants to expand their boundaries in four different ways.
In “agonistic” games, the players must push their skills to meet the challenges of the other players, thereby actualising potential. Competing against another person often forces the players to lift their game and achieve their best potential. However, in an educational environment, attention may need to be focused on the activity and peripheral concerns, such as what the other learners are doing, should be ignored.

“Aleatory” games are enjoyable because they rely on the participant trying to forecast what will happen, beating fate. Hence, gambling becomes addictive because a fortune can be won or lost on the fall of the cards. “Divination is a universal feature of culture, an attempt to break out of the constraints of the present and get a glimpse of what is going to happen” (Csikszentmihalyi 1992:p 73). It is worth noting at this point that some of the literature cautions against gambling, not only because it is considered socially undesirable in some cultures, but also because in an instructional gaming environment it holds some promise for representing some aspects of learner certitude and therefore internal processes of expectancy (Dempsey, et al., 1996). Games which exploit some feature of Alea tend to be engaging for this reason.

“Ilinx” are games that alter the conscious state by making the participants dizzy or giving a physical terrifying thrill, but they do not expand the consciousness, instead, they can cause the participants to lose control over their consciousness or senses, thus getting in the way of expanding their minds. This type of game is usually confined to video arcades.

Games that use “mimicry” exploit the concepts of fantasy and pretence and expand the participants’ limits of reality and experience. Games of mimicry are what children use to role-model adult and gender roles, and adults use them to feel more powerful and try out different roles without threatening their reality. Studies have shown that all these types of games have the following in common:

It [the game] provided a sense of discovery, a creative feeling of transporting the person into a new reality. It pushed the person to higher levels of performance, and led to previously undreamed-of states of consciousness. In short, it transformed the self by making it more complex. (Csikszentmihalyi, 1992:p 74).

A study conducted by (Jones, 1997) examined how computer games engage the users so that a set of guidelines could be built for future game development. From this study Jones (1997) identified a number of engagement factors, namely; appearance of the game, relevance of the features to the environment and the content; mix of
strategy and action, with strategy engaging in the longer term and action providing excitement and giving immediate feedback; problem solving skills, where information is accumulated, assimilated and applied to existing knowledge; experiencing failure, making mistakes and correcting them usually makes deeper connections with the content than being told or memorising an answer; a realistic environment in which the students can exist, succeed or fail; defining and establishing problems which hold the interest of the learner (Jones, 1997). Jones concluded that games are engaging and that it is worth considering incorporating games into learning environments. He does caution, however, that most of his study was conducted with males and that enjoyment of games may be gender specific. However, females do enjoy games which are designed to be gender neutral (see Chapter 8).

An important component of games or play is having flow activities which eliminate both boredom and anxiety. Flow activities lead to growth and discovery and are dynamic in that the challenge changes constantly and is at an optimal level, thus removing both the chance of boredom and the chance of failure (Csikszentmihalyi, 1992). This leads to self-efficacy, making the learners seek more demanding challenges. Surmounting these challenges in turn increases their sense of self-efficacy (Goleman, 1996). Flow activities are also very personal and not every learner will respond to the same challenges or acquire the same skills and this is the challenge for every instructional designer.

If a multimedia program is to engage all students then individual differences must be considered. An area of increasing interest to universities is that of cultural differences and this is an area which is largely overlooked in instructional and content design.

**Individual differences**

The individual differences among learners are another factor which clearly underpins adult learning theory and may have a large impact on their engagement with a task. It is obvious that not all students learn the same content at the same rate; some will understand immediately, whilst others may never master the subject content. This is not always a reflection of student ability, but can be attributed to individual learning styles. Jonassen & Grabowski (1993) support this when they
state: "That learners think, process information, and learn differently is obvious. Those differences affect the courses they take and succeed in, the careers they choose, and even the friends they select...developing an awareness of how individuals differ will clarify the process of learning and the act of teaching for educators and designers in a substantial way".

It is well recognised that individual differences exist, and that individual differences come in a variety of forms—age, gender, cultural background and learning styles. Individual differences influence how the learners filter instruction and either allow assimilation of information, or prevent accommodation of ideas (Jonassen & Grabowski, 1993). Individuals differ in their learning styles—their abilities to process information, construct meaning from it and apply it to new situations (Jonassen, 1993). Different authors view learning styles from a variety of cognitive, affective or physiological perspectives; (Cross, 1981; Galbraith, 1991; Jonassen & Grabowski, 1993). Individual differences have been accommodated by instructional designers in three ways: they have ignored them; they have attempted to accommodate them by prescriptive measures; and they have asked the students to choose their own teaching and learning methods (Winn, 1993). This latter method is reflected in the work done on learner control and can be attributed to many of the features in computer assisted learning (Merrill, 1988).

The design of a program based on the principles of situated learning will need to take into account the amount of control given to the learners. Many programs assume a high degree of control in areas such as sequencing, strategies, questioning and feedback (Orey, 1994) which leads to learners feeling frustrated and disenfranchised. Successful programs have shown to be the ones where the learners generate their own problems or construct their own learning and the teacher or computer program becomes the facilitator or model rather than the controller of the learning process (Orey, 1994).

There has been widespread debate on the best approach to learning, in particular the best way to accommodate individual differences. Learner characteristics can determine how well a student will grasp particular subject material. It is a relatively easy matter to relate individual differences to students’ capacity to acquire behavioural component skills, but much harder to speculate on the acquisition of higher order skills and individual differences (Gropper, 1983), and this is borne out
in the review carried out by Dempsey, et al., (1996) who found that personality traits and cognitive styles were rarely reported on in the literature. However, while cultural and racial characteristics were rarely discussed, gender differences were the most frequently reviewed, with age a close second (Dempsey, 1996).

**Gender differences**

There is a common perception that male and female learners learn differently, particularly with respect to technology, with males being better at spatial related skills and females being superior with linguistic or verbal skills. As most computer based games rely on spatial skills and speed, males tend to perform better. These types of games do not appeal to females, further reducing their motivation to perform well (Thornburg, 1991). Educational games which are free of gender bias and which allow students to work at their own pace have every chance of overcoming some of these differences, allowing females to develop spatial relationships and males to develop their linguistic abilities (Collis, 1985).

Many other studies in education have reported significant gender differences, for example, Malone's study (reported in Loftus & Loftus, 1983) found that females liked music whereas males disliked it; females liked receiving verbal feedback whereas males disliked it; and males liked, but females were indifferent to, the graphics (p 40). These findings were also mentioned by Provenzo (1991).

Malone (1980) also found that females' cognitive development did not differ greatly from that of males and that males and females did not differ in their views of knowledge and learning styles (Magolda, 1989). Females tend to be more concrete in thought than males, with females seeing computers as a means of achieving a concrete goal (Titus, 1990). Females are likely to conceptualise computers as a productivity tool, a medium by which to accomplish a task, whereas males see computers in broader terms, and enjoy them as a recreational toy (Gaicquinta, Bauer, & Levin, 1993). This latter view enables males to push the boundaries of their own knowledge and allows them to excel at the technology. Entertainment software contributes to this view, with much of it being written for males and which often involves the “shoot em up” style of game. There is very little on the market appealing specifically to females, with the exception of games such as Tetris and
Where in the World is Carmen San Diego. These are both adventure games, but rely on problem solving and reflection rather than reflexes.

Studies have highlighted the fact that educational software designers frequently design games for males and learning tools for females (eg. Huff & Cooper, 1987). It is the belief of many (eg. Chaika, 1995) that games designed specifically for females merely reinforce the societal sex stereotypes and, although appealing to gender stereotypes generates the greatest revenue, there is an ethical need to produce educational and recreational software which appeals to both males and females.

In spite of all this conflicting evidence, the gender specific differences found by various studies may simply be a reflection of the ways females and males are socialised, their prior experience and educational backgrounds. However, a recent survey among university students has found that “for the majority of students, but especially women, lecturers’ inclusion of both female and male perspectives in their teaching would have a ‘positive’ or ‘very positive’ effect on their learning experience; and that students of both sex felt slightly more confident in giving their opinions in class when the lecturer was of the same sex as themselves” (Smith, 1996). These findings have important implications for designers of instructional multimedia as they suggest that students are likely to feel happier with a computer program than with a lecturer of the opposite sex; and that they will enjoy interacting with the program more than interacting with the opposite sex. These findings have, however, not been substantiated sufficiently by further research to be treated with anything other than caution.

Age is another factor which people will cite as a reason for lack of learning, and Titus (1990) has found that as adolescents mature their learning styles become more abstract, and that age, gender and aptitude all contribute toward the maturation of learning style, and that a four-year span can make a difference in learning style. He does add that this difference is more evident in males than females, females being more homogeneously concrete thinkers.

Cultural differences

Culture is not necessarily to do with race or home country, it can be a “programming of the mind which distinguishes the members of one category of people from
another” (Hofstede, 1995). The category of people referred to by Hofstede could be distinguished by region, nation, religion, ethnic group, gender, or age.

**Culture defined**

Defining culture can be a difficult proposition. Many different classifications exist in relation to national culture (Parsons & Shils, 1951; Kluckhohn & Strodtbeck, 1961; Hofstede, 1984; Hofstede, 1988). Although it has been asserted that national culture shapes the type of organisations and the nature of social structures (Hofstede, 1980), the nature of this relationship is still rather vague. Supporters of the convergence theory claim that, due to influences such as technology and globalisation, societies will become more and more alike (eg. Burn, 1997); whereas others who support the divergence theory believe that national differences are not only here to stay, but are one of the most crucial problems for business and education (Nelson & Clarke, 1994; Hofstede, 1984; Cheung, 1994). There is also the view that people belong to more than one culture in the society in which they live, learn and work and that they create a subset of their culture rather than remain totally allegiant to their birth culture (Scheel, 1993). This can influence the way in which information is received and subsequently dealt with.

In spite of these differences in theories, there appears to be a consensus that culture does have an influence on the way in which people receive, process and disseminate information. This in turn impacts on the values and attitudes held by members of a society. Values are beliefs that people hold about desirable states of affairs and ways of doing things (Burn, 1997). When values are widely shared by a group of people then this provides them with a common mechanism by which they can share understandings and interpretations of their world, establish what is important and clarify priorities (Burn, 1997). Culture, however, is more than just an abstraction, it also consists of a distinctive symbol system that captures and codifies the important and common experiences of a particular group.

Information is influenced by and impacted upon the various cultures which surround it, and therefore each person’s interpretation of a particular item of information could vary according to their cultural background (Tricker, 1988). Burn (1997) shows the cyclical interaction between culture and information, and the impact of external forces in the following way (Figure 2.8):
Instructional design must therefore, take into account the culture of the society in which students operate. Much of the educational multimedia generally available in Australia “has been designed to cater for the lifestyle and cultural experiences of European-Australian students, or has been imported from England or the United States without modification” (Fleer, 1989, p614), however, Australian universities have a large contingent of overseas students, particularly from South-East Asia. There is therefore, an urgency to develop software which caters for these various ethnic and racial groups which exist in Australian universities, the first step of which involves identifying the various design principles reflecting cultural contexts and learning (Fleer, 1989).

Learning is a process that is influenced by, and results from, the interaction of three areas of influence: agent, activity and world (Lave, 1991). By definition, therefore, it is culturally based at the level of the individual learner, the way in which that person will respond to certain activities, such as group-based or individual learning, and the world in which they learn and in which the knowledge will be applied (Burn, 1977). Educational programs which have been developed only for collaborative learning may thwart optimal learning outcomes where this conflicts with the cultural learning styles of the students (Henderson, 1994). To date, accommodation of cultural differences has been neutralised by blending them together in the instructional design. This is one of the weaknesses of the notion of multi-culturalism
in education—cultures become homogenised, and it has led to the introduction of multiple culturalism and an inverted curriculum approach to instructional design (Henderson, 1996).

**Learning Styles**

Another important individual difference among learners is that of learning styles, and these should be an important consideration in the design of educational programs. It is believed that the learning orientation of students is one of the most important determinants of their academic success (see Dunn & Dunn, 1978), and that when the teaching method is congruent with the student's particular learning style, the chance of success is greater.

The term “learning styles” has a variety of definitions and is often used interchangeably with “cognitive styles”. However, cognitive style generally means:

> ... the cognitive characteristic modes of functioning that are revealed through one’s perceptual and intellectual activities in a highly consistent and pervasive way...and the intrinsic information processing patterns that represent a person’s typical modes of perceiving, remembering, thinking, and problem solving (Swanson, 1995).

The term “learning style”, however, has come to mean the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (eg. Carlson, 1991; Dunn, 1978; Filipczak, 1995; Grasha, 1989; Grasha, 1990; Swanson, 1995).

Learning style is a broad term which encompasses the way individual learners react to their overall environment and includes cognitive, affective and physiological styles (James, 1993). The way learners process information can be quite different, but is generally broken down into two main modalities—global and analytical (Flannery, 1993). Global learners want an overall picture and process information simultaneously, not in any observable order. The information is assimilated in a subjective and concrete manner and needs to resonate with the learner if it is not to be discarded (Flannery, 1993). Analytical learners like the discrete details, broken down into logical steps for processing. Analytic learners perceive information in an objective and abstract manner and don’t need to personalise the information (Flannery, 1993). Global learners tend to be able to hold less in their short term
memory as they have more sorting to do, whereas analytic learners, sorting as they
take in the information and therefore need less structured support (Flannery, 1993).
Teachers tend to teach to their own style which may disenfranchise one group, but
most educational institutions favour the analytic style of teaching and learning
(Flannery, 1993). An holistic approach to teaching, encompassing both styles is seen
as a solution to this problem and this certainly fits in neatly with educational
multimedia, as multimedia is capable of accommodating both types of learners,
although the global learner may extract information differently from the analytic
learner.

Whilst most people fall into the two main categories of global and analytic learners,
and some people are able to process information using either style, learners
generally also have one of three preferred learning style dimensions—cognitive,
affective and physiological (James, 1993).

Although the approaches to learning styles differ, the weight of opinion is that the
majority of adult learners prefer the material to be less structured and in informal
settings with a self-paced, independent approach, using case studies, positive
reinforcement, experiential, self-assessment, visualisation and guided reflection (eg.
Fassig, 1994; Knowles, 1980; Zemke & Zemke, 1995). This style of learning draws on
people's experiences, treats the learners as adults, is capable of adapting to diverse
needs and expectations of participants and should not only develop critical thinking,
judgement and creativity, but should also lead to higher levels of motivation and
engagement. An alternative approach has been suggested which calls for the
reduction of individual differences rather than for accommodation of individual
differences (Gropper, 1983). In order to reduce student differences, they have to be
trained to become self-reliant learners who can identify relevant information and
then search for it efficiently. These skills would then transfer to new learning tasks as
the students become more expert and self-reliant. This "learning-to-learn" is a major
factor in eliminating the gulf caused by individual differences and is a component of
well designed instructional multimedia (Gropper, 1983).

One researcher who has attempted to measure individual differences in terms of
learning styles, age and gender is Kolb (1984). He defines learning style as "one's
preferred method for perceiving and processing information" and has developed an
instrument to measure learning styles, the Learning Styles Inventory (LSI). The LSI
identifies four learning modes which are essentially cyclical: concrete experience (CE), reflective observation (RO), abstract conceptualisation (AC) and active experimentation (AE). Each learning mode has unique characteristics, with abstract learners comprehending conceptually and symbolically, concrete learners need tangible experiences, active learners like to manipulate the variables within the learning environment and reflective learners like to think about what is happening within the learning environment (Jonassen & Grabowski, 1993).

The basic assumption underlying Kolb’s Learning Style Inventory, is that different students undertake tasks differently and acquire information differently. He believes that a student’s learning style may change with age and past experience, and an awareness of these learning styles can lead to the creation of more versatile learning environments.

Other forms of learning styles that are studied are the bipolar construct of Field Dependence and Field Independence that measures the extent to which a person is influenced by the surrounding field (Witkin, 1976). Witkin developed the GEFT (Group Embedded Field Test) which identified how accurately a person could pick out a simple object with the context of more complex figures (Grigg, 91). Field Independent students are those ‘who are able to perceive the figures in the midst of the surrounding field, and are able to function more autonomously because their reliance on internal referents allows them to structure situations on their own. Field dependent people are those who are unable to pick out the figures, and are more influenced by their environment including other people.’ (Swanson, 1995, p 5).

A wealth of material exists on individual differences as they pertain to technology, but the issue of designing instructional materials to accommodate these differences remains. There is a need to produce materials which are free of gender bias, appeal to a variety of learning styles and which can hold the interest of young and older learners alike. One of the solutions to this problem is to design an instructional landscape which encompasses gaming and microworld elements without being gender specific and which appeals to a variety of learning styles through learning activities which encourage the learner to be self-reliant and to search for relevant information from a variety of sources. Incorporation of these aspects are more likely to engage the learner in the content, hence leading to motivation.
Motivation

Motivation is often overlooked in the study of learning and design processes as they apply to instruction, but motivation is becoming more central to multimedia-based learning (Duchastel, 1996). In an attempt to make learning fun, educators and instructional designers have had to look at content, but are beginning to see the great potential of technology.

Situational interest, such as novelty, is a major motivational factor, as is topic interest which varies widely.

Motivation theory is often divided into two main types; content theory and process theory (Alpander, 1995). Content theory is concerned with “what” energises behaviour, while process theory focuses on “how” behaviour is energised (Alpander, 1995). These two theories have been modified by Keller’s (1983) ARCS model and Malone’s (1981) framework for intrinsically motivating instruction.

The ARCS model considers four factors of motivation: attention, relevance, confidence and satisfaction. These four factors lend themselves beautifully to the design of a multimedia learning environment. Gaining and sustaining attention can be facilitated through the novelty of the design, the inclusion of interesting elements such as graphics, movies and sounds as well as the exploratory nature of the environment. The use of dysfunctional attention-getting effects is cautioned against by (Keller, 1988), and the use of only relevant attention-getting elements is recommended.

Relevance of the content and interface can lead to intrinsic motivation. The material should be closely aligned to the learners’ long-term goals and should enable them to find personally relevant material that matches the learning outcomes (Keller, 1988).

Confidence and satisfaction are related to the students experiencing feelings of achievement and success. They generally act on time-on-task over a period of time and pertain to learner control, attainment of goals, feedback, discovery of new opportunities and information and the ability to model on experts (Duchastel, 1996). Confidence and satisfaction are part of competence, which is often a motive for exploration and play (Kinzie, 1990).
Chapter 2

Review of the Literature

Keller’s theory draws strongly on expectancy-value theory, which is a belief that acting in a particular way will be followed by a particular outcome (Keller, 1983). If there is certainty that the outcome will happen then the expectancy is 1.0; if there is certainty that the outcome will not happen, then the expectancy is 0.0, and values can range between the two. The valence—intensity of the desire for achieving the outcomes—affects the performance of a student. The primary motivational influences are values and expectancies, where the student will approach activities or goals that are seen to be personally satisfying and for which they expect to achieve success; hence the term “expectancy-value theory”.

Keller (1983) agrees that if students expect to succeed then their personal motivation increases. They will look at their past performances in a given task and be able to gauge fairly accurately their expectations for success, however if the task is too easy then they will become bored and if the task is too difficult they will become anxious and frustrated and their motivation in both cases will decrease (Keller, 1983). In order to increase students’ expectancy of success, they need to experience success, so tasks should be graded in difficulty and feedback should be accurate and supportive of the tasks. If the feedback does not connect success to the personal efforts of students, they will experience what Keller describes as learned helplessness. Learned helplessness is the belief by students that the outcomes are uncontrollable. Research into learned helplessness hypothesises that inability to control outcomes results in three types of deficits—cognitive, motivational and emotional (Martin & Briggs, 1986). Cognitive deficits revolve around unrequited expectancies for success and retard future learning; motivational deficits revolve around negative responses; and emotional deficit revolves around depressed affect (Abramson, Seligman & Teasdale, 1978, cited in Martin & Briggs, 1986). The effects of learned helplessness can be reversed by the application of attribution theory (cf. Dweck, 1975) where the learning materials are modified to increase the expectation of success, the goals and expectations are more realistic, the tasks are graded in difficulty and a review of the reasons for failure being due to abilities or lack of abilities rather than luck or chance (Martin & Briggs, 1986).

The production of high quality educational multimedia for adults—materials which learners will want to use—may then depend on a number of different, but complementary elements such as motivation and play, and it is therefore essential to
explore the theoretical foundations for adult motivation and learning with multimedia.

**Attributes of motivation**

A major goal of education is to motivate the student both intrinsically and extrinsically, and there is a belief that multimedia and, in particular, multimedia games have the power to achieve this. Curiosity is the most direct intrinsic motivation for learning (Malone & Lepper, 1987). They distinguish between sensory and cognitive curiosity with sensory curiosity being particularly important in multimedia games. Malone (1980) also explores the difference between intrinsic and extrinsic fantasies and their place in the motivation of the learner. Games which involve elements of fantasy are able to evoke images of social situations or physical objects, and intrinsic fantasies are more effective than extrinsic fantasies as the intrinsic fantasy is dependent upon the skill being performed and the skill is dependent upon the fantasy (Malone, 1980). For example, in a microworld, the fantasy is a situation in which the learner would not normally be able to be engaged, and the skill involves learning to move around the microworld in a real and meaningful way. An extrinsic fantasy is domain-independent, the learner would be able to acquire the skill and knowledge with or without the fantasy.

There has been some discussion that increasing motivational appeal will correspondingly increase learning but this contention is not proven in the existing research (e.g., Dweck, 1986), although Lepper and Malone (1987) theorise that embedding educational activities in an appealing fantasy context should offer an effective means of enhancing intrinsic motivation. They believe that enhancing learner interest in relevant learning opportunities and investing mental effort may increase learning (Salomon, 1983). It is important to note that learning is enhanced only when the fantasy elements support and reinforce the learning goals of the activity (Parker & Lepper, 1992), and that the fantasy can be maintained while proficiency increases and learning goals change (Lepper & Malone, 1987). When designing educational materials based on a fantasy context, care must be taken to ensure that the goals of the learning materials and the fantasy itself are congruent with one another (Lepper & Malone, 1987).
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Goals may be considered on two levels—target and competence purpose goals (Harackiewicz & Sansone, 1991). Target goals are generally task specific (such as correctly solving a problem) but can lead to higher order goals such as demonstrating competence at an activity (Dweck, 1986). This class of goals is known as competence purpose goals, and are useful for inducing feelings of competence and accomplishment which in turn produce feelings of satisfaction thereby promoting intrinsic motivation (Harackiewicz & Sansone, 1991). Students do not naturally set themselves competence purpose goals, but having them set by an external source may interfere with the learner’s motivation (Harackiewicz & Sansone, 1991). Both types of goals may also be influenced by individual differences of the learners but they are often a critical component of self-regulation so should be fostered by the learning program (Harackiewicz & Sansone, 1991). Students undertaking the learning program described in this research will decide how they want to play the game and what their own goals are, but the key to maintaining their intrinsic motivation may be the degree to which their performance goals promote competence while achieving their target goals. (Harackiewicz & Sansone, 1991) believes that if the two goal levels match, intrinsic motivation will thrive, this in turn leads the student to have an autotelic experience. An autotelic experience is a term used by Csikszentmihalyi (1992) to describe a self-contained activity with no expectation of reward, completing the activity is reward enough.

An important aspect of a gaming experience is to allow the user to actually notice changes in understanding and therefore notice that learning is taking place. This has an impact on the motivational effects of the program and causes the learner to stay engaged in the activity (Norman, 1994). There is a view that the motivational effect of accretion type learning—adding new facts to existing schema—is considered to be both enjoyable and fun, whereas construction learning—learning something completely new and unrelated to any previous experience the learner has had—is difficult and aversive (Draper, 1997). It doesn’t necessarily follow that construction or reconstruction of knowledge will therefore be avoided, but adding some motivational elements will increase the likelihood of learners being willing to invest the intellectual effort required.

Motivated activity is both challenging and rewarding, but in order to achieve this the learner needs a continual flow of focussed concentration, known as “optimal
flow" (Csikszentmihalyi, 1990; Norman, 1993). Optimal flow is easiest to sustain in experiential mode, and that in order to maintain flow, interruptions should be avoided; this could be an interruption by the computer or by a person (Norman, 1993). Generally, people exert this sort of mental effort during recreation, not education.

This type of focussed attention is generally known as “immersion”. There are two aspects of immersion—the physical and the psychological (Hedberg & Harper, 1996). The physical immersion is the way in which the learner plunges into the instructional environment, and the environment represents a rich image of a real world place or situation; but the environment must also contribute towards a learning goal and the learner must recognise this contribution for the environment to be meaningful. Hedberg & Harper (1996) also discuss motivational immersion which is similar to the optimal flow described by Norman (1993).

Based on the above discussion, it would appear that the multimedia environment needs to have some particular features. A theoretical framework of the elements and

![Diagram](image)

Figure 2.9. Factors influencing motivation and engagement

the way in which they lead to, and enhance, motivation is shown in Figure 2.9.

One of the main advantages of multimedia over traditional CBT and CBL is that interactivity is possible. Interactivity is however, proving to be an elusive concept,
difficult to define (eg. Oliver, 1996) and even more difficult to integrate into an instructional design. It is common for the interactivity to be reduced to mouse clicks which allow the user to advance in a linear fashion through the program, but, as described by Wills (1996) it goes beyond mere point and click, and could more aptly describe active environments that engage the learner in a challenge or mission based on manipulating the information contained in the system. Interaction may be better defined as engagement. When designing an interactive system it must be kept in mind that inexperienced students may become confused. The system should therefore include information about learner control options which should be appealing and non-threatening (Kinzie, 1990).

To make engagement intrinsically based, the learners’ main motive is to satisfy a knowledge requirement. They have an expectation on the type of content they will find, and work carried out by (Jacques, Preece & Carey, 1995) suggest that “...the learners' ability to find and use information is heavily influenced by their subjective opinions of their task and the media available to them” (p 56). Although it is important that learners be able to choose the type of media which best suits their learning, Jacques, Preece & Carey, (1995) “…urge designers not to use a variety of choice as a means of making their products more engaging, but instead to use the most suitable ones anticipated for learners' needs” (p 56), in particular taking into account the technological limitations of some media available and the effect those limitations may have on the delivery and reception of the material.

The above discussion identifies various factors that influence motivation and engagement. These have been further distilled into eight learner effects of immersion, reflection, flow/play, learner control, collaboration, curiosity, fantasy and challenge.

Immersion

This link between engagement of personal internal processes and immersion is summed up by (Leyland, 1996) when he states:

> However, perhaps the most important criteria for learning in games is sustained imaginative immersion of the player. This immersion allows the player to invest something of themselves in a game or learning experience as they fully engage with the role. This personal investment
is a critical factor in achieving deep learning, as learners will then mediate their own learning experiences (p. 4).

A sense of immersion can be achieved by creating a first person experience (for example, no gender or cultural bias), and by participating in authentic and anchored activities (CTGV, 1993; Brown et al, 1989; Lave, 1988). In order to be immersive, an interactive multimedia environment needs to be intuitive and experiential, and this view is summed up by Trip Hawkins, Chairman of Electronic Arts who is quoted as saying:

*Really good software products should be simple, hot and deep. People need to get into your software in about 20 seconds and get immediate positive feedback and reward; then they are smiling and having a good time and they want to go further* (cited in Vaughn, 1994).

Another factor to consider when designing educational multimedia is that high arousal can result in positive valence which can result in increased immersion. Skelly (1995) suggests that when faces are used in a computer interface, the emotional engagement increases substantially, leading to the students feeling increased affect and immersion (see Figure 2.10). In this figure Skelly demonstrates the fact that when objects in a program are humanised (ie when they have faces), they are much more likely to arouse positive feelings towards the program, than when students are confronted by buttons or icons. The “sweet spot” shown in this figure is the optimum point of arousal for students when faces are used. This is a factor that should be considered when creating interactive multimedia environments for learners.

![Figure 2.10](image-url)
Reflection

Reflection is an important part of developing higher order thinking and problem solving skills. It allows the learner to draw upon prior experience and apply that experience in new contexts. However, it is a neglected area of learning as pointed out by Duley (1981, cited in Boud, Keogh & Walker, 1985) when he says “The skills of experiential learning in which people tend to be the most deficient is reflection” (p611). There are three stages of reflection: preparation, engagement in an activity, and the processing what has been experienced (Boud, Keogh & Walker, 1985), and the student needs to understand the goals of the activity, plan strategies for accomplishing those goals, practice skills, and make connections between the theory and the practice. Even when the formal learning requirements have been completed, the students need to reconstruct their experience, think about what they have learned and the actions they took to make some sense of the experience. Reflection is therefore required before, during and after completing the learning activity and the activity should encourage and accommodate this.

Consequently, reflection is a learner activity that can be encouraged and assisted by teacher or multimedia program intervention, but it cannot be done for them. It is a purposeful activity, directed towards a goal, and if the student has positive feelings towards the learning activity, they are more likely to remain on task and are more likely to take an exploratory and experiential approach to the activity (Laurillard, 1993, Resnick, 1987b, Boud, Keogh & Walker, 1985).

Flow/Play

Another important part of motivation is the way in which the program involves students in the activity, creating a sense of enjoyment and enhancing a state of flow. Flow can be described as “...the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it.” (Csikszentmihalyi, 1992, p 4). When an experience is optimised, skill levels and comfort zones are expanded and boredom, frustration and anxiety are relieved (Csikszentmihalyi, 1992). Flow can be achieved in a learning activity by the incorporation of humorous and gaming elements and optimal challenges. Csikszentmihalyi’s (1992) theories of agon (competition against self, the experts or if appropriate, against other students), alea
(random elements that give the learning activity the element of “chance” and allow the learner to discover new opportunities) and mimicry (alternative reality) are also useful in creating a sense of enjoyment. Enjoyment is described by participants in a variety of activities in the same way—regardless of culture, age, gender, or educational background (Csikszentmihalyi, 1990, p 48).

Humour is another attribute of play that can greatly enhance students’ motivation to participate in a learning activity. However, humour is often culture specific and needs to be used with caution in a learning environment or program which has a potentially wide audience.

Collaboration

Many studies report that students who work together experience a greater sense of motivation and engagement (e.g. Bates, 1996; Lesgold, 1995). Collaboration involves not only student working cooperatively together, but being able to question, summarise, predict and clarify the information in a social experience. This view is summed up by Shneiderman (1993) when he says:

> I see more clearly than before that the path to motivating students is the joy of creation, exploration and discovery. I see also that these processes are social in nature and that shared experiences in class and through teamwork projects are vital (Shneiderman, 1993).

An emphasis on collaboration rather than competition helps build positive attitudes towards the learning activity. Dalton et al (1989) sum up this problem when they say that the “…isolation may unintentionally limit the richness and meaningfulness of the resulting learning” (p 21). Collaboration is an important component of learning because psychologists have long believed that individual cognitive skills are developed in a social context (Resnick, Levine, & Teasley, 1991). These social interactions may be horizontal (student-student) in nature, or vertical (student-teacher or student-program) (Entwhistle & Ramsden, 1983).

Learner control

In curriculum design there is an emphasis on direct instruction with teacher control—teaching by transmission, rather than students adopting an active role in their learning and the teachers engaging in diagnosis of individual capabilities (Campione, 1996). Learner control is the amount of latitude a learner has over
direction and depth of learning (Litchfield, 1993). Learner control has been one of the most researched areas of computer based instruction, and allows the learners to select the paths, content, pace and nature of the feedback they receive (Reeves, 1993c). This finding has been replicated by Murphy & Davidson (1991) who found that learners completed the tasks faster but did not have superior recall or retention of concepts. These findings would suggest that a balance between learner and system control may enhance learning whilst retaining the motivational effects of control. However, control also has to be adapted to the age and background of the learners, some learners (especially lower ability students) become confused with high levels of learner control (Ross & Morrison, 1988; Litchfield, 1993), and students who are not used to having control over their learning may take time to adapt to it. In order to overcome this problem, an interactive multimedia program can incorporate help in the form of advice that adapts as the learner moves through the program (Leutner, 1993). Allowing learners to choose between a number of options can enhance their feelings of self-efficacy and learner control thereby leading to increased motivation (Ross & Morrison, 1988).

Whilst learner control has the capacity to better engage the learner, it will only achieve this if the program appeals to the learner cognitively and affectively. Important elements of learner control are guided discovery, scaffolding, modelling and adaptive advice.

Curiosity

Arousing curiosity may be achieved by creating an experiential and exploratory environment which is optimally complex (not too difficult, not too easy) and which appeals to as many of the learner’s senses as possible. Curiosity can be aroused when learners believe their knowledge structures are incomplete, inconsistent or unparsimonious (Malone, 1981). Curiosity incorporates concepts such as novelty, complexity, surprisingness or incongruity and feedback in the form of reward can also increase a learner’s curiosity (Berlyne, 1968; Malone, 1981). These all describe cognitive curiosity; however curiosity can also be sensory. Technology provides a powerful opportunity to stimulate sensory curiosity because of the special effects it can create (Salomon, 1979). Sensory curiosity involves attention attracting effects such as animation, colour, and unusual interactive exchanges (Salomon, 1979).
Fantasy

Having a realistic metaphor for the instructional landscape can allow students the fantasy of believing that they are actually participating in the environment rather than experiencing a feeling of being a user of it. Fantasy has been identified as a prime intrinsic motivating factor in learner (Malone, 1980, Malone & Lepper, 1987, Parker & Lepper, 1992). However, opponents have branded the incorporation of fantasy elements in learning environments as attempts to “sugarcoat” teaching (eg. Psotka, 1982), although in later writings Psotka appears to change this view (see Psotka, 1995, 1996).

Fantasy also aids in the transfer of information from the learning environment to the real world (Low, Venkataraman & Srivatsan, 1994) by allowing students to visualise their learning in context, stimulating their senses and engaging them in a realistic and immersive environment.

Challenge

A learning activity which necessitates a high degree of problem solving and higher order thinking with an appropriate level of difficulty, will cause students to feel a reasonable degree of challenge. The reward structure should be authentic and appropriate to the context and all students should know the goals of the learning activity. By allowing a reflective review of strategies, students can instantly identify whether their goals are being met and how successful they are at meeting the challenge.

Optimal challenge also involves an appropriate reward structure, reflective review of strategies, and problem-solving and higher order thinking (eg. Grundy, 1991).

It is clear from this section that many factors relate to, and enhance, motivation and engagement in learning.

Task

Task is the second main element of motivation and engagement according to Jacques, Preece & Carey (1995) as exemplified by Figure 2.11.
The way in which the task is designed and delivered to the student can have an impact on the way in which the students learn from it and the amount of enjoyment they derive from it. Consequently, there are various attributes of learning environments which need to be considered in order to make the tasks more engaging for the learners. The design of the task should also strive to achieve learning outcomes that are relevant to the learners' needs, both present and future.

As illustrated in Figure 2.11, task has two sub-components—attributes of interactive learning environments and learning outcomes which are described in more detail below.

**Attributes of interactive learning environments**

Instructional landscapes are the "interfaces in which learning occurs through the interaction between the learner on the one hand and instructional resources and activities on the other" (Duchastel, 1993-94:p. 226). The design of instructional landscapes can be accommodated by a process dubbed "Learning Environment Design" or (LED).

According to (Duchastel, 1993-94) LED may succeed the more traditional Instructional Systems Design which has gained popularity over the last thirty years. LED is based on learner centred activities and emphasises the cognitive individuality of the learner. A learning environment needs four requirements for learning to take place: information, interest, structure and regulation.
Access to information is imperative for learning to take place and if real-world information is not available then an artifactual substitute is useful (Duchastel, 1993-94). Interest is the element which causes the learner to explore the environment and to stay on-task. Curiosity is a major component of interest and the novelty and sensory aspects of educational multimedia contribute to the attention-getting devices.

The real world is the best interface for learning, however most learning done in universities is conducted via lectures and books. Simulations are a hybrid mixture of real-world learning and classroom-based learning (Duchastel, 1993-94).

Simulations have firmly positioned themselves into adult education, in particular in adult business education. Simulations may be defined as an activity which requires only that an event be completed (Dempsey, 1996), whereas a game is any "overt instructional or learning format that involves competition and is rule-guided (Dempsey, Lucassen, Gilley & Rasmussen, 1993-94). A simulation which produces an overall score allowing learners to compete against themselves by improving their score or beating the computer, is considered to have a gaming mode (Dempsey, 1996). Simulations, case studies and games have been around for several decades and their use and value are well documented. The digital convergence which the world is currently experiencing will mean that learners will have flexible access to a wide range of data sources and that simulations will take on elements of expert systems and artificial intelligence. Game designers will use microworld techniques through which the content can be woven and in fact the game will be able to be customised and incorporate composite scenarios allowing the learners to test strategies and play out opinions. A program in this context will be a combination case study, enterprise simulation, complex behavioural simulation and action learning project (Keys, 1994). Keys goes on to hypothesise that universities will orientate their teaching/learning formats to experiential laboratories (using microworlds) rather than simulations occurring in the lecture/classroom situation.

Computer based microworlds provide opportunities for students to experience and explore an environment, enabling them to derive a better understanding of the required learning tasks. There is research evidence that physics microworlds containing gaming features, have been found to qualitatively alter students'

A microworld is an environment simulating a small part of a real environment through which the learner can explore and discover context specific information. Papert (1980) who can perhaps be credited with the conceptualisation of microworlds through his work with LOGO, suggests that microworlds should be simple, general, useful and syntonic—connecting new knowledge to old.

Microworlds are capable of including the six motivational factors as outlined by Wlodkowski (1985) of attitude, need, stimulation, affect, competence, reinforcement, as well as fulfilling the motivational factors outlined by Malone (1980) of curiosity, challenge and fantasy and by Keller (1988) of attention, relevance, confidence and satisfaction (ARCS). A well designed microworld is capable of leading the learner with little or no expertise through to a high level of expertise. Whilst it is providing scaffolding and coaching it is creating interest, stimulating the learner’s imagination and building confidence. Once the learners have acquired a degree of competence the microworld fades the coaching so that the learners are exploring and meeting challenges on their own.

Microworlds are also capable of fostering what Hedberg and Harper (1996), call “information age learning skills” of exploration, problem solving, inquiry, collaboration and media handling. These skills are going to be vital to the inhabitants of the information age and their acquisition a matter of survival for students and workers alike (von Wodtke, 1993).

Although conventional simulated learning environments, such as microworlds, simulations and games, are well respected in business education, there is a view that they trivialise learning and therefore there is great resistance to them in the wider academic community. Computing itself is considered a “serious” science and a no-frills approach is taken to the design of business applications. This attitude often leads to the development of complex, uninteresting programs which, whilst being academically respectable, are not fun to use and are therefore not used.

A gaming environment, however, can provide an obvious means of combining theory and practice, or for allowing theory to be put into practice. Games usually provide “...clear goals and expectations, a clear role or purpose for the learner, a
meaningful context for a learner to judge whether or not their actions/responses are appropriate, feedback that makes sense, motivation built on individual curiosity and optimal challenges, etc" (Rieber, 1997)

Human-computer activity can be divided into two categories—productive and experiential (Laurel, 1993). Games and microworlds can combine both experiential and productive activities, but it is the experiential mode which engages the mind by "the constant arrival of a barrage of sensory information" (Norman, 1994). Many games have a browsing mode, whereby the user can click on objects to see what happens; wander around a microworld; or skim through text, ignoring sounds and images, and they can also incorporate an instrumental mode whereby the user can be engaged in goal directed searching (Laurel, 1993). This type of activity is stimulating and compelling because it is event driven, presenting new challenges and constantly changing the stimulation, all of which are necessary for motivation and engagement (Norman, 1994). However, designing a task to enhance motivation and engagement does not necessarily automatically lead to learning outcomes, which is one of the goals of any learning environment.

Learning outcomes

In spite of all the expectations, there is a wealth of evidence to suggest that instructional multimedia does not contribute significantly to learning (eg. Thomas & Hooper, 1991; McClure, 1996; Moore & Kearsley, 1996; Wilson, 1996). This view has been supported by Russell (1997) who, in a review of over 200 references to research studies that look at different learning technologies used since the 1940s, found an overwhelming amount of evidence that there was no significant difference in learner performance when technology was used, rather than the traditional classroom instruction. The issues raised by this particular review are: whether the pedagogical approach had changed to accommodate the intrinsic features of the technology being used; and whether consideration had been given to accommodating the affective domain of the learners. One outcome of the review was that, although there was no significant difference in learning outcomes, it highlights the fact that learning outside the traditional classroom can be just as effective as learning within it.

The question to be asked, then, is how can a technology based course be designed to produce better learning outcomes than a classroom based course, which leads to a
discourse on the way in which the media is integrated into the learning process.

**Media**

Media is the third main element of engagement and motivation as demonstrated in Figure 2.12.

![Diagram of Instructional Design Theory]

Figure 2.12. Identifying Media as one of the elements of motivation and engagement (Jacques, Preece & Carey, 1995).

There is much controversy surrounding the "does media matter" debate with some stating that media is merely the vehicle by which learning is delivered (Clark, 1994) and does not influence the learning itself. This has been refuted by Tripp (1996) who asserts that "...there is a direct causal relationship between the medium of instruction and the amount of declarative knowledge retained by students." and concludes that "media does influence learning" (p 7). Kozma (1994), on the other hand believes that researchers should move away from the 'media influences learning' debate and instead consider "In what ways can we use the capabilities of media to influence learning for particular students, tasks, and situations?" (p 18).

No discussion of the use of technology or media in teaching is therefore complete without some reference to the way the media is designed to accommodate individual and cultural differences. Individuals process, absorb and remember new information in different ways and the way the program is presented will have an impact on the way the learners use it.
Consequently, it is important to investigate the various instructional design attributes of an interactive learning environment, including issues such as interface design, and the accommodation of culture as it pertains to the design of an interactive learning environment.

**Design of an Interactive Learning Environment**

Ten basic elements of program design modified from those identified by Duke (1980) are useful to consider when developing an interactive learning environment:

1) **scenario**—the scenario sets the scene and outlines the plot of the game or simulation and the roles of the various participants. A metaphor may be a useful means of determining the scenario.

2) **pulse**—A pulse is a problem or event which focuses the participant's attention.

3) **cycle sequence**—there are two levels of cycle sequence—macro and micro. Macro cycle sequences are those pertaining to the introductory aspects and concluding aspects of the program and also any evaluation processes. Micro cycles take into account any aspects occurring within each macro cycle, such as the presentation of information.

4) **steps of play**—these are the progressions of the program and include the learners becoming familiar with the program, taking into account problems, considering new data which becomes available, taking action, making decisions, relating material to real-world problems, evaluating their own performances, learning from previous actions and applying new understandings to future actions. The steps of play may provide learners with guidelines for playing as well as stimulating participation. The ultimate goal is to increase learning and enrich knowledge of the content being explored.

5) **rules**—a learning environment is usually rule driven and, if this is the case, these should be determined at the outset. Rules should be inherent in the program and able to be determined by exploration and experimentation.

6) **roles**—learners should have an innate understanding of the role they are playing in the game, with the scene being set in the initial screens. Roles should be implicit and as free of social and cultural bias as possible.
Chapter 2

Review of the Literature

7) models—models are devices which keep track of the logical processes. Programs may be based on one of three types: (a) heuristic, which is the simplest and most commonly used; (b) iconic which use a representation of reality; and (c) analog models which parallel the real-world.

8) decision sequence and linkages—the links between the events and learners' actions should be identified prior to developing the program. It is at this point that feedback and information flows are determined.

9) accounting system—this deals with the players' decisions. Each decision has to be processed, acted upon and forwarded to another part of the learning environment.

10) paraphernalia—all the things needed to run the program, such as the basic computing requirements.

Interface design

Instructional designers are routinely urged to consider screen design as an integral part of creating a multimedia program. Guidelines for designing the interface are common, but they often overlook how to motivate the student. There are several elements to consider when designing for motivation: creating interactivity; incorporating learner control; creating screens that are appealing; making the program intuitive and easy to use and accommodating cultural differences. It is important that the student be considered a participant in the process, rather than just as a user of the product (information designer, Edward Tufte points out that there are only two industries that call their customers users—those selling technology and those selling drugs (in Gould, 1995). As Gould (1995) states, this affects the attitude towards them and the quality of their engagement.

Good interface design leads naturally to other facets of good design, such as interaction design, designing for reduced cognitive load, designing for learning control and designing for ease of use and functionality. Interface design is central to these elements as highlighted in Figure 2.13.
A first step in designing an interface that has the potential to motivate, is to identify a theme or metaphor that can create a sense of immersion. This metaphor needs to be realistic and relevant to the target audience. For example, *Investigating Lake Iluka* (described in Harper & Hedberg, 1997) is a program about environmental issues developed for high school science students and contains all the elements (a notebook, a diary, news reports, video tapes, and so on) that students would expect to come across if they were actually doing environmental research. The ability to browse is important and *Investigating Lake Iluka* allows students to explore by browsing through various screens to get an overview of the program. Browsing also allows students to build their own learning paths. However, not everyone wants to browse, so a good program will contain hints or clues about where to go first, to accommodate students who do not like exploring and who prefer a more structured approach.

The following figures show the difference between a program designed for a highly structured, hierarchical approach with high levels of system control, and those designed for non-linear browsing, providing high levels of user-control.
Chapter 2

Questioning Episodes

Question Types

Types of Interaction

Judging Responses

Response Feedback

Record keeping

“Questioning Episode includes the asking of one question, the response from the learner and the feedback given.”

Interactive multimedia is still in its formative stages and the interface design used in many programs reflects this. It seems as though the inspiration for the design in Figure 2.14 is derived from productivity software with buttons and menus being the main means of navigation. This causes the user to hurry through the program to complete the task quickly and efficiently, with a resulting loss of engagement (Gould, 1995). In contrast, Figure 2.15 shows a more organic interface that allows the participant in the program to click on objects, rather than buttons. This interface is more intuitive than that in Figure 2.14, but is still not representative of an environment that students can relate to in their everyday lives. Two examples of
realistic environments that use iconic representations of objects for navigation can be found in *Investigating Lake Iluka* and *Exploring the Nardoo* (described in Harper & Hedberg, 1997). Both of these programs use a narrative approach to their interface design.

If a narrative approach to interface design is taken, rather than a navigation approach, then the interface will be more likely to encourage exploration and allow the students to discover information about the environment from the environment. This notion is summed up by Don (1990) when he states:

"...the result is a heuristic interface that emerges out of the material represented in the knowledgebases, rather than a control-structure interface that is slapped onto the content after it is assembled...Narrative enables characters and graphics to convey information from a particular point of view, with the characters playing the role of guides to navigation and also sources of content...Further research should investigate which characteristics of narrative can be applied as an interface to a variety of multimedia knowledgebases. The research can lead to the development of a narrative genre of multimedia interfaces.” (Don, 1990:p. 391).

This narrative style of interface design encourages the learner to explore and spend time in the environment, therefore increasing the likelihood of engagement with the environment. The process of engagement leads to reflection (which too often is neglected) (Laurillard, 1995) and reflection leads to understanding (Norman, 1993). If the bare minimum of buttons and menus are provided, the user will have to decide where to move next and how to explore the environment. This deciding involves time (and therefore engagement) and a degree of reflection that cannot be emulated with software that has a productivity look and feel to it (Gould, 1995). However, if this technique is to be successful, the interface should be intuitive and simple and students may need to be taught to explore if they have never used this type of program.

Breaking the program into manageable chunks by having "rooms" (screens) through which the learner can move (which they can "drill"), reduces the complexity and allows the learner to form a mental model of the program to help them navigate. Learners should have a good mental picture of where they are; what they can do...
here; how they got here; where to go next; and how to get there. It is the surface
details of the interface, the typography, screen layout, language, icons and
signposting that are basic to the learner’s sense of place (Jones, 1989).

A great deal of work has been done on interface design on single screens, but, with
the advent of multiple screen multimedia, there is a need to think about the learner’s
total experience across the whole program. Learners will become lost unless they
understand the interrelationships between the different screens (Woods, 1984), with
the initial screen providing orientation to the entire program (Jones, 1989).

Although multimedia embraces image, sound, video and text, it should be
remembered that text is the most credible medium (Laurel, Oren & Don, 1992).
Video and audio should be able to stand alone and not merely supplement or
enhance the text. However, images are superior to words for remembering concrete
concepts as they are coded visually and verbally, whereas words are coded only
verbally. Where both modes of coding are present, the chance of information
retrieval are doubled (Paivio, 1991).

Many multimedia authoring programs have visual effects such as wipes, zooms and
fades. Use these with caution as they become very irritating very quickly. New
designers use them because they appear impressive, but they can be unengaging and
so focus the student on the flamboyant interface rather than on the content, as well
as increasing the mental load of the students. The best user interface demands the
least learning effort (Vaughn, 1994).

The interface connects the learner and the content and helps to shape the interactive
experience. It must appeal to as many of the learner’s senses as possible, be
functional, aesthetically pleasing and provide, without hindrance, the information
access and guidance that learners need (Francois, 1996). In order for the interface and
the graphics to be aesthetically pleasing, the following things to avoid should be
kept in mind (adapted from Vaughn, 1994, p 405):

• colour clashes

• busy screens with too much in them

• trite humour in oft-repeated animations
• clanging bells or squeaks when a button is clicked

• overelaborate pattern borders

• requiring more than two button clicks to quit

• too many words

• too many substantive elements presented too quickly

An avoidance of these elements, together with careful consideration of the navigation sequences and methods can greatly enhance a program’s functionality (Vaughn, 1994). Vaughn identifies the following four fundamental organising structures which are used to navigate around a multimedia program, and they are often used in combination:

• Linear—the learners will navigate through the program in a series of sequential steps;

• Hierarchical—learners navigate along the branches of a tree structure that is shaped by the natural logic of the content;

• Nonlinear—learners navigate freely through the content;

• Composite—learners may navigate in a nonlinear fashion, but can be constrained by linear presentations of items such as movies or critical data which is logically organised in a hierarchy (adapted from Vaughn, 1994).

These four navigational structures are represented in diagrammatic form in Figure 2.16.
Navigation is an essential component of interface design. The success of the interface design depends, not only on the myriad of features already outlined, but also on the means by which students will navigate through the program. Allowing the learner to move at will wherever they wish is considered to be important as "this empowers them within the context of the subject matter" (Vaughn, 1994, p 393). The design of the navigation has an impact on the way students recognise essential information and identify the sequence by which they will move between elements. Instead of using the *form follows function* method of interface design, a more useful design model is that of *form infers function*. In other words, allow the interface to suggest to the learner what it does and how it operates (Jones, 1989).

Learners will often construct spatial mental models in order to move freely around a program and within the learning spaces and this has obvious implications for design (Sellen & Nicol, 1990). Designing a program which allows the learner to intuitively navigate using their mental model reduces their memory load and cuts down on the amount of time it takes the learner to learn to use the program. This mental model or "map" tells the students where they are in the program and allows them to infer how to get from point A to point B without trying to keep a navigational model in their heads (Sellen & Nicol, 1990).
Cognitive Load

Cognitive load refers to the amount of information that can be held in short term memory at any time. Screen layout has an important impact on cognitive load.

Key information should be presented in prominent locations on the computer screen, with related data grouped and separated. Fixed locations should be used for certain data so that learners develop a spatial sense of where the data is to be found (Jones, 1989). The amount of information and how tightly packed it is should be considered when the display is designed. This is known as display density. On a computer display, errors increase as display density increases (Tullis, 1983). Much of the literature on interface design has a corresponding description of the basic human physiology that must be accommodated when designing multimedia interfaces.

The fovea, (visual area) of the eye has a limited field of focus (about four letters wide), so the eye constantly and unconsciously scans the screen (Card, Moran & Newell, 1983; Jones, 1989). Motion and shape predominate in the wider peripheral field, so objects must be placed so that they stand out in the student’s peripheral field of vision. Other aspects of screen design that make text more readable should be considered, such as spacing, size of text, colour of text and of background, white space and separation of the display into distinct objects (Jones, 1989).

A key factor is the spacing between items, as speed and accuracy when reading text are both influenced by spacing. Reading is accomplished by recognising both letters and overall word shape. The single most important visual characteristic in recognising words is the initial letter (Treurniet, 1980) so having sufficient space around the words increases the ease with which they are read. The sensitivity of the fovea is influenced by the information at the periphery. When more information is present in the periphery, the useful field of view effectively contracts, and this causes a slower scanning rate. (Treurniet, 1980). A cluttered screen will therefore increase cognitive load and decrease the speed at which information is assimilated.

People read text significantly more slowly from a screen than from books (28% more slowly) (Jones, 1989), so text should be kept to the absolute minimum with point form being more suitable than prose. Select a font that allocates differential spacing to characters depending on their widths (proportional spacing). Proportionally spaced text reduces reading times, requires fewer eye fixations and draws better
viewer ratings for visibility and reading effort (Helander, Billingsley, & Schurick, 1984).

Not only do computer monitors vary, but the users may have a variety of colour perceptions. A few factors to be considered are: (a) older people are less sensitive to colour and need brighter colours, and they also lose their ability to see blue (Marcus, 1986); (b) 8 percent of the male population and 0.5 percent of the female population suffer red/green colour blindness (De Grandis, 1986); (c) cultural differences can have an impact on recognition of colour, and (d) even occupational differences can create variations in recognition of colour. Using colour in combination with shapes or locations can help to overcome some of these problems (Salomon, 1990).

Colour coding is useful to highlight related data, but designers must be careful not to unconsciously assign levels of importance through the chosen colours. For example, red is often assigned to important items and blue and green to less important items. Red is also the colour that is most often chosen by people devising their own colour coding, although red often flags “danger” (Salomon, 1990). To limit the need for refocussing, avoid colour pairs such as red/blue, yellow/purple. Reds, oranges, yellows and greens can be viewed together without refocussing. Opponent colours go well together—red/green, yellow/blue; but not red/yellow, blue/green. Red and green should be avoided in the periphery of large displays, whereas yellows and blues work well in the periphery.

For text, colours in the centre of the spectrum (yellow and green) and white are more easily perceived than colours at the extremes of the spectrum (blues and reds). Pure blue should not be used for text, narrow lines, or small objects as the fovea cannot focus on blue. For the same reason, blue makes an excellent background colour.

Cognitive Optimisation

Intrinsic motivation is maximised when the mismatch between the learner’s cognitive structures and the demands of the interface and the environment are at an optimal level. This enables the learner to be pushed without being overwhelmed by new information, when negative intrinsic motivation is likely to occur (Biggs & Moore, 1993). Too little demand and the learner will be bored and unchallenged by the environment. This relationship between interface and instructional demands, and intrinsic motivation are summarised in Table 2.1.
Table 2.1. Intrinsic motivation and the demands of an interface (after Biggs & Moore, 1993)

<table>
<thead>
<tr>
<th>Cognitive Demand</th>
<th>Motivation</th>
<th>Interface Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>Low</td>
<td>Unchallenging</td>
</tr>
<tr>
<td>Optimal</td>
<td>High</td>
<td>Challenging</td>
</tr>
<tr>
<td>Maximum</td>
<td>Low</td>
<td>Overwhelming</td>
</tr>
</tbody>
</table>

This theory of optimal mismatch will vary with the preferred learning style of the learner. This learning style is biologically predetermined and the learner will naturally resist instructional delivery which is contrary to their preferred learning style. The environment will therefore need to take this into account and accommodate a variety of learning styles and cultural differences rather than try to fit the learner to the instruction (Wild, In press); Murray-Harvey, 1994).

**Accommodating cultural differences**

Productivity software is designed to be localised (adapted to users from different cultural backgrounds) and internationalised (built so that cultural elements are easily accommodated when the software is adopted by a different culture) (Greenwood, 1993).

Language is the obvious cultural difference and written language varies, not only in the words and symbols used, but also in the form. Even English varies considerably across cultures, particularly in its orthography. Orthography consists of the rules of spelling and pronunciation (Greenwood, 1993), for example American English and British English orthography are quite different, even the conventions for date and time vary.

In English and many other writing systems, the letters are written from left to right, from top to bottom, but in some South-East Asian countries, letters are traditionally written vertically, with the lines flowing from left to right. Semitic language scripts (Arabic and Hebrew) are written horizontally from right to left with lines moving from top to bottom. When designing educational software for use in a Western society, there is a view that students will adopt the conventions of their host country,
particularly as they are using the language of their host country. However, there are some conventions which are harder to adopt and those are the conventions for date, time and numeric values as these tend to be enculturated into the learner. Date and time formats are now quite widely understood across cultures, and indeed most computer systems allow the option of choosing style of date and time according to the country of choice, but numeric values still have the potential to cause confusion as the separators used with numbers to express quantities vary between nations. In Australia, the United Kingdom and the United States, the comma is used as a thousands separator and the full stop as a decimal separator, but in continental Europe the opposite is true (Greenwood, 1993).

The user interface is the obvious point at which cultural differences will make themselves felt, "the interface designer must be aware of issues of geometry management, images, symbols, colour, and sound" (Greenwood, 1993:p.14).

**Geometry Management**

Graphical interfaces in most Western cultures use menu bars aligned at the left and drop down menus falling from left to right. Menus in Hebrew and Arabic cascade from right to left. Japanese and Chinese designers have adopted the Western convention for technical material. Due to these differences, instructional and interface designers should consider using an intuitive interface which does not contravene any cultural conventions. However, there are significant cultural differences in images, sounds and colours used.

**Images**

Images are not culturally neutral. In order to make an image culturally neutral it will have to be abstract and completely foreign to all cultures. As (Greenwood, 1993) states "This may meet the requirements of internationalisation, but at the expense of good user interface design" (p 7). In an intuitive interface design, images are selected as mnemonics, but the meanings of images may vary across cultures. For example a cross indicates prohibition in Western cultures, but may not mean the same thing in other cultures. Ticks and crosses should be used with caution if internationalisation of the program is to be achieved.
Chapter 2 Review of the Literature

**Colour**

Colour can have a variety of meanings across cultures. Table 2.2 has been adapted from Russo & Boor (cited in Greenwood, 1993) and gives the associations of colour across six cultures. The traditional western view of a red "X" meaning danger, would for example, not have the same meaning in Egypt as red is not associated with danger and the "X" does not have a forbidden connotation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Red</th>
<th>Blue</th>
<th>Green</th>
<th>Yellow</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Danger</td>
<td>Masculinity, conservatism</td>
<td>Safety</td>
<td>Cowardice</td>
<td>Purity</td>
</tr>
<tr>
<td>France</td>
<td>Aristocracy</td>
<td>Freedom, peace</td>
<td>Criminality</td>
<td>Temporary</td>
<td>Neutrality</td>
</tr>
<tr>
<td>Egypt</td>
<td>Death</td>
<td>Virtue, faith, truth</td>
<td>Fertility, strength</td>
<td>Happiness, prosperity</td>
<td>Joy</td>
</tr>
<tr>
<td>India</td>
<td>Life, creativity</td>
<td></td>
<td>Prosperity, fertility</td>
<td>Success</td>
<td>Death, purity</td>
</tr>
<tr>
<td>Japan</td>
<td>Anger, danger</td>
<td>Villainy</td>
<td>Future, youth, energy</td>
<td>Grace, nobility</td>
<td>Death</td>
</tr>
<tr>
<td>China</td>
<td>Happiness</td>
<td>Heavens, clouds</td>
<td>Ming Dynasty, heavens, clouds</td>
<td>Birth, wealth, power</td>
<td>Death, purity</td>
</tr>
</tbody>
</table>

**Sound**

There is a paucity of research on the impact of sound in educational materials across cultures. However, the use of beeps to denote errors has been found to cause Japanese users embarrassment when sitting in a room full of co-workers (Taylor, 1992). Sound should be considered carefully because of the potential to cause irritation to other students, and the ability to turn it down or turn it off altogether should be enabled.

New technology reflects the existing culture, but it also contributes towards creating new cultural norms. Students from other cultures immediately begin adapting traits from their host countries and after a short period of time begin to adopt some of the more superficial conventions. However, some of the deeply ingrained cultural norms need to be considered and accommodated by instructional and graphic designers.
There is a need for more research into the relationship between learning styles, learning environments and learning outcomes. Cultural differences could promote different learning outcomes (Hayes & Allinson, 1995).

Another issue to be considered when designing an interface for an interactive learning environment is that of control.

The last major issue in designing the environment, the interface and the information to be incorporated, is that of interactivity.

**Interactivity**

Browsing is possible only if the multimedia is interactive and non-linear. Interactive multimedia (IMM) can be defined as an electronic program in which the user participates in the activity rather than observing passively (Morrison & Morrison, 1994). Barker (1994) (cited by Sims, 1995) defines interactivity in learning as essential to learning. True interactivity happens when the senses are engaged in the action and the users feel they are participating in it (Laurel, 1993).

Selnow (1988) identified three critical features of interactivity: tailored to the receiver, relevant feedback, and facilitating the two-way flow of information. Borsook and Higginbotham-Wheat (1991) take these three features further by adding immediacy of response, non-sequential access to information and granularity. Granularity or grain size, is the degree to which the participant in the program can interrupt the flow of the program, for example, clicking on another object will stop a voice over or video from running.

Early IMM used a stimulus-and-response approach whereby challenges were set and incentives or rewards were offered. Early users of this approach were video games, but IMM has moved on to incorporate education and entertainment—often known as *edutainment*. Today, many designers and producers of IMM are from the theatre arts industry, reflecting on emerging entertaining educational software. As Sims (1995) states, “...interactivity is an art because it requires a comprehensive range of skills, including an understanding of the learner, an appreciation of software engineering capabilities, the importance of rigorous instructional design and the application of appropriate graphical interfaces. This brings together the instructional designer, the software designer, as well as the content expert.
However, interactivity is proving to be an elusive concept, difficult to define (see Oliver, 1996) and even more difficult to integrate in an instructional design. It is common for the interactivity to be reduced to mouse clicks which allow the user to advance linearly through the program, but as Wills (1996) states “interactivity goes beyond mere point and click... (it means engaging) the learner in a challenge...to manipulate the information...in the system. Interaction may be better defined as engagement.”

For a program to be interactive, the student needs to form a mental model of how the program looks and functions. As described earlier, the mental model is a mediator between perception and action, allowing the student to interpret, remember, control their performance and communicate information (Wild, 1996). The mental model will be developed slowly over time, and as the student explores deeper into the program, his or her mental model of the program will evolve and alter (Norman, 1983; Norman, 1986).

Task design is another important facet of engaging the learner. There is a growing body of research showing that skills and knowledge are best acquired within realistic context (eg. Grabinger, 1996; CTGV, 1993c; Hannafin, 1992; Goldman, 1992). Microworlds, for example, play a role in learner engagement through the delivery of information, practice, findings and presenting information, stimulation of high level thought processes, promotion of collaboration and exploration (Grabinger, 1996).

A microworld is a type of interactive learning environment and is generally a simplified form of a real place or situation. It should have a capacity to increase in complexity and sophistication as the learner progresses (Rieber, 1995). The microworld can be based on a form of reality which can be determined by different criteria. For example, reality can be described as “…a simulated experience in which characters, actions, messages, or themes in some way conform to real life; something is judged real if it is deemed possible” (La Follette, 1993). Jonassen (1988) believes that the learner disengages from the real world by "bracketing it out”, whilst accepting that the content and context of the media are real. If microworlds are to engage and motivate the adult learner, then an analysis of what elements need to be included should be undertaken.
Microworlds are capable of providing the necessary elements for an experiential mode of learning: concentration and focus; the condition to be practiced; appropriate feedback and guidance; and, importantly, the ability to reflect upon and analyse performance. Microworlds allow for systematic exploration, collaboration with coaching and scaffolding, and learning with challenge and reward (Norman, 1993). This is the ideal environment for education, that students who experience "continual stimulation, simulated worlds...their attention and motivation take care of themselves" (Norman, 1993).

Summary

The literature has provided a wealth of information to guide the development of interactive multimedia for adults. It has provided assistance and guidance across such domains of content as interactivity, engagement, motivation, interface design, information design and accommodating individual differences.

Synthesising this has led to the identification of eight potentially important attributes for materials that might motivate and engage adult learners. These are immersion, reflection, flow/play, collaboration, learner control, curiosity, fantasy and challenge.

The literature describing presentation and interaction formats has suggested a microworld as an ideal environment in which to encompass these eight attributes, and the various fields of interface, information and interaction design have suggested an approach of a mimetic interface as being potentially powerful.

To further explore this, it became the intention of this study to implement these findings into an interactive multimedia program Principles of Financial Investment and to explore its ability to motivate and engage adults in meaningful learning.

Research Questions

The study aimed to obtain a response to the following research questions:

What is the effect of an IMM microworld with the eight attributes on the motivation and engagement and learning of adult learners? In particular it will investigate:

1. How do students use a learning environment which incorporates the eight learner effects?
2. *In what ways were the eight motivational learner effects achieved?*

3. *How did the microworld impact on learner activities and engagement?*

This chapter has given an overview of the literature on learning theory and higher order thinking, and engagement—including individual and cultural differences, motivation, media and task development. From this literature review elements have been identified which, when incorporated into an interactive multimedia program, may prove to be motivational and engaging to adult learners.

Chapter Three will discuss how all these elements contribute to the design methodology of an interactive multimedia program.
Chapter Three

Program Development

This thesis involved the purposeful design of a program which included the eight previously identified motivational attributes of immersion, reflection, learner control, collaboration, flow/play, curiosity, fantasy and challenge. This chapter describes the way the program was developed and includes discussion of the design processes—interface design, information design and interaction design.

As described in the previous chapter, the literature suggests that microworlds could be potential vehicles to carry the eight learner effects. Microworlds can incorporate elements of situated cognition, authentic instruction and feedback, and they can be made realistic and relevant to the students. They can be designed with intuitive interfaces and made to accommodate a wide range of individual and cultural differences. Microworlds can also be designed to incorporate varying degrees of learner control and can be highly interactive.

Planning

Selecting the Content Area

The Faculty of Business at Edith Cowan University sponsored the design of an instructional multimedia program that would provide an exemplar to other faculty members wishing to consider designing multimedia environments for their own units.

A review of appropriate business units was undertaken to find a unit or a module within a unit that would allow the researcher to experiment with the critical attributes of motivation that had been identified. A unit or part of a unit which had a traditionally theoretical presentation, lack of realistic practical application and which the students perceived to be generally pedestrian was required. A module called “Principles of Share Investment” in an introductory finance unit was selected because it met all these criteria and it was considered that an interactive multimedia solution could address these concerns.
Principles of Share Investment is a three week module in the unit and is largely taught from a textbook in a lecture and seminar format. This is a share market unit where students learn about wealth maximisation, as well as general financial theory and financial formulae. The theory is discussed, but the students are not able to transfer their knowledge to a real world situation in such a short time frame. An instructional landscape in the form of a microworld is considered to be a good solution to this problem. A microworld “generally provides an open ended environment within which the learner may explore the possibilities inherent in some domain of knowledge” (Scandura & Scandura, 1988). It was considered that this medium would enable the incorporation of the eight learner effects already identified from the literature as being most likely to enhance motivation and engagement.

The concept of the microworld also provides students with the opportunity of completing realistic tasks in a realistic setting, enabling the incorporation of the principles of situated cognition and expert practice. Situated cognition allows students to acquire knowledge in context—the physical setting in which it will be used (Brown, 1989). Situated cognition puts the student in the position of an “apprentice”, learning tasks in an authentic situation, having control over the pace, direction and timing of their learning, and a microworld is one means of replicating this situation via a computer program, whilst accommodating at least one of the eight learner effects.

The microworld also supports the notion of “expert practice” where the student is able to use a built-in expert for modelling or scaffolding, which is then faded in a natural way as the students build confidence in their ability and knowledge (Brown, Collins & Duguid, 1989). This is a form of collaboration—the student collaborates with the computer, thereby accommodating another of the eight learner effects.

**Intended Learning Outcomes**

The overall learning objective of the program was to provide students with the ability to value shares and accurately forecast prices. The program encompassed not only an environment that is realistic and authentic, but also all the theory, in a variety of forms, required to make good investment decisions. This allowed the students to confidently invest based on their understanding of the theory while they watched the effect of
variable market forces on the share prices. It is the ability to interpret world events in order to make buy and sell decisions that maximised the value of an individual’s share portfolio.

The program was designed to include Gagné’s (1984) five types of learning outcomes, although motor skills are not appropriate. These are intellectual skills, cognitive strategies, verbal information, motor skills and attitudes. The program was planned to provide the ability to build on the students’ intellectual skills by allowing them to apply basic rules; generate their own rules based on experience; and identify concrete concepts not specifically outlined in the theory. The program also needed to develop cognitive strategies to help students to remember the tutorial information. Cognitive strategies can be developed through the problem solving approach taken in the program.

Development Issues

A development team consisting of an instructional designer, a content expert and a programmer was formed. Each member of the team had expertise in at least one of the other areas which resulted in a synergy between the members and the program outcomes.

A needs analysis conducted at the beginning of the design phase highlighted the fact that the program would need to be cross-platform compatible with both Macintosh and IBM compatible computers, as the Faculty of Business used both platforms. Students studying both internally and externally at Edith Cowan University have a range of equipment from 386 Intel chip based machines with 4Mb RAM and single spin CD drives through to Pentium 160’s with 24xspeed CD drives; a small number also has an assortment of Macintoshes. Although a number of students did not own equipment with CD-ROM drives, a decision is made to produce a program suitable for CD-ROM because of the expected size of the program.

Once the needs analysis had been conducted, the team began to look at the design of the program and the interface that might most appropriately provide the students with the information, knowledge and skills in the most engaging way possible. The use of the term interface in this thesis is used to describe the bridge between the content and the participant. It encompasses the organisation of the material, the screen design and the
layout, the use of the space and the way in which the participants move through the program. Because of the complexity of the material, it was decided to break the program development into three main domains based on Gould's (1995) model. These domains are information design (content), interface design and interaction design.

Figure 3.1 outlines the development model for the program, with evaluation as a central point due to the fact that it was an ongoing and constant process with minor adjustments being made to the program. After the analysis phase, information, interactions and interface were designed concomitantly, rather than separately and sequentially. These were constantly evaluated as the different program elements were designed, and the authoring and media were also designed simultaneously, built into the three design elements and evaluated constantly. The integration of the eight motivational attributes was then discussed and put in the context of content, interaction and interface design.

![Diagram](attachment:image.png)

**Figure 3.1. The development model used for Principles of Financial Investment**

Implementation and support and maintenance were then considered, once the program was developed and evaluated.
Information Design

The first step in information design was to define the audience and plan and organise the content. A target audience analysis was conducted to determine the type of student who would be using the program and it was discovered that it had to appeal to both sexes, a variety of cultural groups, and an age range of 18 to 55. It was decided that it was important that the student be considered a participant in the process, rather than just as a user of the product. This profiling of the likely participants to determine their needs and wants was an important first step in the design of the program (Gould, 1995; Laurel, 1991). An example of a user characteristics checklist is included in Appendix 2.

A concept map (Figure 3.2) was used to map the content and to define the relationship between each of the elements. It was decided that a microworld would keep the context authentic while allowing the designer to incorporate some gaming elements necessary to keep the learners engaged and on-task. The microworld also allowed a blend of theory and simulated practice which is difficult to achieve with other solutions.

![Concept Map](image)

Notes: 
- Each box equals a screen
- The four boxes within the dotted line constitute the students' 4 main working/operating areas & hence the student must be able to move between these with reasonable ease

Figure 3.2. Concept Map showing the relationship of each element
It was during this design phase that the form, structure and function of each element of the program was determined. A concept map was developed and storyboards scripted. The storyboards were used as a rough schematic guide which allowed greater flexibility and input from the programmer. The storyboards gave the programmer an opportunity to efficiently program the learning environment without constant recourse to the instructional designer and content expert, but allowed sufficient flexibility to suggest changes when a better way of doing something is found. It was during this phase that the limitations and desired outcomes of the program were identified and documented. Some of these limitations were caused by the cross-platform difficulties, and these were eventually resolved by focussing on one platform only.

The program was designed to consist of an office building called “Investment House”, which is representative of many stock exchange buildings around the world. In order to simulate an investment environment, there are six stocks, ranging from blue chip to speculative, and six quarters. The quarters are designed to give an extended period of time so that students can get a long term perspective on share price fluctuations and what causes them. The quarters are labelled 0-5 to correspond to real world financial terms, quarter 0 being the current or first quarter. The program encompasses both the theory of investment, delivered via on-line tutorials, as well as other, more practical, sources, and the application of the theory in the form of share trading.

Figure 3.3. First screen of the program showing Investment House and the save and retrieve mechanisms.
The first screen in the program sets the scene, with a voiceover giving instructions. The automatic teller machines on the right hand side of the image (Figure 3.3) provide the means of saving data to disk and retrieving it. This enables students to exit the program at any time and to return to their last location when they re-enter.

A reception area containing a help desk which gives varying degrees of hints regarding where to start and what paths to follow is the next, and only mandatory, screen. In order to personalise the program for each individual student, a register is filled in when they enter the reception area. This also allows the storage of data on a server or floppy disk, and it also allows the students to receive $100,000 to invest in the six stocks or to buy any of the on-line courses. The \( \text{I} \) button on the reception desk is designed to give hints and tips on how best to use the program if a student becomes confused as to where they should go first (Figure 3.4).

![Figure 3.4. The Reception area, showing the register and information icon.](image)

From the reception area it is possible to move in a non-linear fashion, anywhere else in the program. To facilitate this, a blueprint of the floorplan of the building (Figure 3.5) showing the other organisations within the building is designed. These are the four main working/operating areas; the stock exchange, a stock broker, the Institute of Sound Investment and the student’s office.
Figure 3.5. Showing the floorplan of the four main working/operating areas.

The Stock Exchange

The stock exchange has a reception area which is able to give help and information, and there is also the choice of visiting the library or the viewing gallery as can be seen in Figure 3.6.

Figure 3.6. The stock exchange reception area with the library and viewing room being accessible through the appropriate doors.
Chapter 3 Program Development

The library

The library replicates stock exchange libraries all over the world, and contains background information on the six stocks, such as the quarterly reports; historical information, and the market and economic data. As the information on the shelves is selected, it is transferred to the filing cabinet in the office. As new information becomes available—such as economic forecasts and news releases—it is stored in the library. The bookshelf expands as students move through the quarters and new information regarding each company is shelved as in Figure 3.7.

![Figure 3.7. Three quarters worth of information as stored in the library.](image)

Information is in the form of current and historical data on each of the six stocks, thereby being an important resource for the students as they can use much of it to make their investment decisions.

The viewing gallery

The viewing gallery is designed to allow visitors to see the progress of any of the six stocks at any time displayed on a stock board. The stock board is active but not interactive, the value of the shares changing from quarter to quarter. There are a number of people in the viewing gallery, two having their faces to the participant (Sean and Wanda). These two on-line characters represent a means of collaboration for students working alone, as well as expert models (Figure 3.8).
The person with the pleased face (Wanda) is the expert performer and when clicked on, her portfolio is available for viewing, a voiceover gives the reasons for her choices, and her investment decisions can be tracked. These decisions are all linked back to the "best practice" highlighted in the theoretical tutorials. Material is therefore available in the form of decisions an expert would make in light of all the information present at that time.

The person with the unhappy face (Sean) is the non-expert performer who displays the worst case scenario. Sean's decisions are generally not based on sound theoretical principles, rather he invests on whim or "gut feelings". His results, therefore, tend to be poorer than Wanda's, although the vagaries of the market do sometimes provide him with a windfall. The modelling provided by Sean is a "how not to make investment decisions".

The on-line characters are designed to provide another form of student feedback. For the first two quarters it is possible to repeat investment decisions based on the information provided by the on-line characters and the price movements. However, after quarter two this "gift of hindsight" is then removed and the option of returning to an earlier quarter is no longer available. In this way the on-line characters can be used
for scaffolding in quarters zero and one only, thereafter, they may be used only as a means of feedback and comparison.

It should be noted that Wanda (the expert on-line character) can experience bad investment results because even with perfectly applied theory, world and random events are able to affect share prices unexpectedly. This is the nature of share investment and it is therefore deemed important to build this element into the program. In the same way, the irrational investor can make a correct investment decision, even when going against the theory. Again it is felt that it is important to show this element as it occurs in real investing.

**The Institute of Sound Investment**

It is considered essential that the concept of paying for continuing education be represented in the program, and the Institute of Sound Investment is typical of many organisations that exist in the stock market environment. The Institute facilitates the continuance of education into the processes of share investment. There are four courses available; three are charged for on a sliding scale, and there is a quiz, which is free. The aim of this area is to promote the notion of investment in education and life-long learning.

The Institute has a reception desk which introduces students to the Institute and dispenses information on the Institute and the courses available. The courses are listed on a large board on the wall and provide learning objectives when clicked on, as in Figure 3.9.
Figure 3.9. Institute of Sound Investment and board showing range of courses and prices

Courses available

- Principles of Investment — cost is $100
- Using the Discounted Cashflow Technique to Value Shares — cost is $200
- How to Invest in Shares — cost is $300
- What do you know? — this is free

When the course title is clicked on, a list of course objectives appear and the options of cancelling out of the course or enrolling are given. If the “Enrol” button is selected, the student’s account is debited with the corresponding fee for the course. As the courses are produced in an HTML environment, the Netscape browser is then launched and the student work through the tutorial covering it as superficially or as deeply as they wish via a series of hypertext links. Figure 3.10 is an example of the first tutorial, designed to reduce the amount of information on the screen at any one time. The material is indexed so that it can be viewed in a non-linear way in order to facilitate rapid exploration (Gygi, 1990). This supports both random browsing, or linear access, accommodating the learning styles of potential students.
Chapter 3

Introduction

Why do we invest?

Time value of money
- Inflation
- Inflation and interest rates

Valuing future cashflows - single period model
- Example

Valuing future cashflows - multi period model
- Example 1
- Example 2
- Example 3
- Example 4

Special Cashflow Streams
- Annuities
- Example 5
- Example 6
- Ordinary Perpetuity
- Example 7
- Deferred Annuities and Perpetuities

Time Value of Money

Inflation

To value an investment properly we need to recognize the fact that the worth of cashflows changes through time due to factors such as inflation.

A simple example demonstrates this....

A pair of shoes would cost me $100 if I bought them today. If I choose to purchase the shoes a year from now and the cost of the shoes rises by 10% to $110, then I would need an extra $10 dollars to buy the equivalent of $100 pair of shoes today.

It follows that if I were given the choice of receiving $100 today or $100 one year from now I would choose to take the money today.

Figure 3.10. Example of a screen from Netscape showing the hypertext links in an index format on the left-hand side, with theoretical information in the right hand frame.

Once the course has been paid for it is transferred to the filing cabinet in the office for students to peruse at any stage of the program. It is also possible to print a hard copy of the material or save it to a disk. A search mechanism is also available if a student wished to search for a particular item or keyword. Students are expected to be able to apply the theory learned in this section to their share trading.

This area does not change from quarter to quarter and is available in all quarters.

The Office

This is designed to be the student's office and contains a desk with a portfolio summary, a telephone which can be used to get help and to give help and hints, a filing cabinet linked to the library files and the Institute course notes which have been bought, a clock which is the mechanism by which students can move to the next quarter (known as
warping) and a television set to enable students to watch news releases and stock market updates.

In order to build in ethics, the telephone is designed to ring at random intervals, delivering messages that could be unethical. Some of the messages are designed to sound unethical, but are, in fact, quite innocent. These messages are designed to force the student to carefully consider the content in the light of their knowledge on ethical issues. Decisions then have to be made on whether or not to act on the information.

As described earlier in this chapter, the program has been designed to give students the option of moving backwards, with the benefit of hindsight (and the advice of the on-line characters), to review some of their earlier investment decisions. This option is accessed through the clock. By clicking on the clock the smooth transition between each of the quarters in a move known as “warping” is facilitated. Warping is accompanied by a flashing signal and an appropriate noise as shown in Figure 3.11.

![Figure 3.11. The student's office whilst in warping mode. Warping is achieved by clicking on the clock and a dialog prompt box comes up allowing them to move on, move back (available quarters 0 & 1 only) or remain where they are.](image)

The program builds up the student's portfolio history as they move through each warp. Figure 3.12 shows the portfolio, designed to allow students to move backwards through previous decisions by clicking on the tabs at the side. The portfolio also gives instant feedback in the form of coloured arrows. Red down arrows show a loss, green up arrows denote a profit from the previous quarter. The portfolio is also designed to show
the total value of shares, balance of available funds and the notional portfolio value, so that students will be able to identify how much overall profit or loss they are making to date.

![sue's Portfolio Summary, 4th Quarter](image)

Figure 3.12. This is the portfolio summary available by clicking on the papers on the student’s desk. The student is able to review each quarter’s investments as well as check progress.

**The Stockbroker**

The stockbroker’s office is another source of information on each of the six stocks, containing brochures on the companies, flyers giving market updates, economic forecasts and even some off-beat information such as “investment by the stars” available in one of the quarters.

The stockbroker’s office also has the buy/sell area in the form of a screen. This screen contains information such as the balance of available funds, funds spent on purchases, funds generated from sales, bank interest earned and brokerage fees expended. The screen is designed to replicate as closely as possible the transaction information that real life investors would be given (see Figure 3.13).
Chapter 3 Program Development

Figure 3.13. Share Portfolio screen available in the broker's office showing all relevant information pertaining to share transactions.

General

The program is designed so that students have the option of exiting at any time up to Quarter 2 to begin the program again.

The content is organised into a coherent whole and the issues of where and when the various media could be accessed are addressed. The form of the instructional landscape is determined and the organisation and navigation methods designed so that the participants would feel both kinesthetically and cognitively involved.

Interface Design

This phase of the program development determined how the content and interactions blended, the look and feel of the program decided and the manner in which the content is accessed resolved. A conscious decision was made to keep the interface simple, with cartoon style 8-bit graphics rather than realistically rendered images. This meant that the images took up very little memory and used minimal space, therefore being able to be used on fairly low level equipment. It also meant that the interface could be developed quickly and cheaply, allowing design efforts to be focussed on the educational elements of the program. Simplicity of interface was achieved without destroying the context of the program by designing a metaphor with which the students could immediately relate—a simulated stock exchange environment.
It was decided to use a first person approach, where the participant enters his or her name and they then become the “owner” of the share portfolio and the office. First-person sensory qualities are important in creating satisfying human-computer experiences and present experiences rather than information (Laurel 1991). As Laurel points out “Learning through direct experience has, in many contexts, been demonstrated to be more effective and enjoyable than learning through information communicated as facts” (Laurel, 1991:p. 119). This use of the first-person also overcomes the problems of gender-bias and cultural and age differences. Figure 3.14 shows how the student’s office can be personalised to them, with their name on the wall, and although only the arms show, the student is still placed within the environment.

![Figure 3.14. An example of how the interface is designed in the first-person, helping to overcome age and gender bias.](image)

A key step in the interface design is deciding upon a metaphor to use. In this case the form did infer the function in that the metaphor of a stock exchange building is an obvious choice, together with the attendant industries—a securities institute, broker’s office and participant’s office.

**Navigation**

The navigational map outlined the connections or links among the various areas of the content and formed an “organiser” of the content and messages.

In terms of the navigation, three questions are kept constantly in mind: Where am I? How did I get here? Where can I go? The navigational map can take many forms and for this
program it was decided to include an information blueprint on the wall of each "room" in the program. It was felt that this is the most intuitive way of allowing the participants to move through the program, and clicking on doors in rooms allowed them to get into ante-rooms in a natural way.

Breaking the program into manageable chunks by having "rooms" (screens) through which the learner could move, reduced the complexity and allowed the learner to form a mental model of the program to help them navigate. Learners should have a good mental picture of where they are; what they can do here; how they got here; where to go next; and how to get there. It is the surface details of the interface, the typography, screen layout, language, icons and signposting that are basic to the learner's sense of place (Jones, 1989). It was deemed essential that the first screen the learners saw provided an orientation to the entire program.

A map on the wall was designed to allow the students to click and move immediately from room to room. Students should, at all times, be able to see where they can go and where they have visited. Each room has an information point that allowed the learners to get information or help if needed. An exit sign was positioned in each room allowing students to leave the program at any time, as shown in Figure 3.15.

![Figure 3.15. Screen capture showing the main reception area with blueprint map to aid navigation, information point and exit sign.](image-url)
If at any time the students do not wish to choose their own path through the system, they could be given hints on where to go next by clicking on the information sign on the reception desk in each room.

**Interaction Design**

Interactivity is the most recent component of IMM and has not yet evolved to the point where it is a communications device (Gould, 1995). Interaction design determines how the program works and how the learner acts within the program. It is at this point that navigation and control are decided and outlined in the storyboard (Francois, 1996). The storyboard is an extension of the concept map and is a rough approximation of what the end user will see and do on every screen. The objective is to keep the user oriented to the content through a system of controls and feedback (Francois, 1996) (a sample storyboard is included in Appendix 1). The storyboards were organised sequentially, screen by screen, and each screen had design notes and specifications prior to rendering. The nature of the interactions were carefully considered for the microworld (now called *Principles of Financial Investment*) and it was decided that the elements and techniques should be very different from those in mainstream computing systems. Buttons and menus were eliminated as they denoted a productivity device and this program aimed to keep the participants on task for as long as they needed in order to acquire the information, solve problems and make decisions; by engaging over time, the participants experienced a sense of change (Gould, 1995). It was therefore decided that the program needed to maximise the quality of time spent whilst reducing the complexity of the processes. In other words, the program was to be simple but engaging.

The program was designed to feel as natural as possible and once the participants got used to the interface it was anticipated that it would become “invisible” to them so that they could get on with *experiencing* rather than *using* the program.

It was important in the design of the program that the participants felt as though the money they were investing belonged to them and that they would have a psychic and emotional involvement with the content rather than be totally objective. This was achieved through the use of the first-person experience and the authentic setting. In this
way their investment decisions and problem-solving were much more realistic and meaningful and they took longer over those decisions, considering all the possibilities. The ability to view an expert and compare their own decisions with the expert’s in light of the theoretical foundations presented in the program also impacted on the nature of the interactions.

Usually in a computer system, the user must have a degree of competence in order to access the information in it. This program is designed for learners with a limited background in computing and is created to support browsing to permit a more flexible means of accessing the data. Although there is an optimum, primary path through the program, the non-spatial organisation permitted flexible browsing. Browsing is possible only if the multimedia is interactive and non-linear. Due to the fact that the learner can move through the program in any order, they can use the simple navigation system to constantly check elements such as economic forecasts, theory elements from the Institute and company background information held in the Broker’s office. This is considered to be important in assisting the students to achieve the learning objectives.

In order to get the sense of time, the concept of warping was developed so the participant was able to travel forward at quarterly intervals and at will to investigate the price rises and falls in their stocks. During these intervals random events were activated which impacted on the prices. The process of warping also allowed the media to be updated quite naturally and without the participants experiencing a sense of disorientation when objects suddenly appeared (such as books in the library). The use of time warps also limited the complexity of the information available for access at any one time. This progressive disclosure was chosen as a way of keeping the information presented within manageable bounds (Jones, 1989).

Accommodating a variety of learning styles is an important focus at this stage and an overlapping network of models are the easiest way of overcoming the problem. Consequently both text and audio are used throughout the program with the students being given the option to turn off the audio if they found it irritating. Students are also given control with the option to browse through the program, discovering elements and creating their own learning paths, or they can elect to use the help and hints option which suggests where they can go next.
Although a microworld was selected for the program design, a way of teaching the theoretical components without having the students wade through screens of text was necessary. The theory also needed to be presented in a way which is consistent with the authentic context of the rest of the program. It was decided to simulate an internet environment which allowed the use of hypertext links and slide shows if necessary. This environment also allows the students to save their tutorial materials to disk, print them out and use the search facilities. The application allows Netscape to be launched real-time for those students with an internet connection, or have a simulated Netscape browser on CD-ROM for those without it.

**Engagement**

The aim of the program is to maximise engagement and motivation, so it was important to avoid a passive click and read type program. The interaction style is important as it supports the narrative intention, enhancing the participant’s relationship with the product. People like to be engaged on many levels simultaneously, so the product’s form, content and function should work together to create a single coherent experience communicating with the participants on a visceral level (Gould, 1995; Laurel, 1991; Low et al, 1994). In this way an IMM should use the principle of *form infers function* rather than *form follows function*. In other words, rather than deciding on what the aims of the program are and designing it to fulfil these aims, the design should reflect the function so that the program becomes intuitive and the interface itself suggests to the user what it does and how it operates (Jones, 1989). The contention is that a program which incorporates the three elements of information design, interface design and interactivity design as described, has the capacity to improve the ability of the program to motivate and engage. The issue then, is how best to integrate the eight previously identified learner effects necessary for motivation and engagement in this type of learning environment.

**Integration of Attributes**

Once the basic concept of the microworld has been arrived at and the program design mapped out, it is important to ensure that it meets the motivation and engagement needs of the students by incorporation of the eight attributes of immersion, reflection,
learner control, flow/play, collaboration, curiosity, fantasy and challenge, as highlighted earlier.

The following tables summarise the way in which each attribute is integrated into each component of the program, outlining the information design, or content, the interaction design and the interface design and how they relate to each other.

In order to incorporate the motivational elements of immersion, reflection and flow, the program interface needed to be realistic and navigation intuitive so that students could understand that pointing on objects would move them to another location without having to remember complex navigational rules. Students also need to have a mental model of where they are in the program and could decide where to go next without having to spend time learning to use the program. Time spent deciding where to go and what to do is reflective in nature. The use of quarterly intervals breaks the information into manageable chunks so that students do not feel overwhelmed with material to master at any given time. The combination of these techniques encourages a convergence of the following three motivational attributes producing a “thematic coherence, meaningfulness of action to the domain of representation, and meaningfulness of the problem in the domain the learner” (Quinn, 1997) and thereby contributes to the overall learning outcomes of the students.

Table 3.1 Integration of the attributes of Immersion, Reflection and Flow into the program components

<table>
<thead>
<tr>
<th>Content</th>
<th>Interaction</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Immersion</strong></td>
<td>The content is designed to accommodate a variety of learning styles and cultural needs. The content is realistic. The students needed to understand the learning goals and recognise the contribution the environment made towards achieving the goal in order to make the environment meaningful and achieve immersion.</td>
<td>The interface is designed to reduce distractions and attempted to make students feel physically involved as well as cognitively and emotionally. A first-person approach is also used to create a sense of &quot;ownership&quot;. The stock exchange metaphor is also an important step in creating a feeling of immersion.</td>
</tr>
<tr>
<td><strong>Reflection</strong></td>
<td>The content is largely unstructured to encourage the student to make a considered decision as to where to move in the program.</td>
<td>The challenge of accurately forecasting share prices and seeing the impact of that forecasting made the program more realistic and meaningful and encouraged students to take longer over their decisions.</td>
</tr>
<tr>
<td><strong>Flow</strong></td>
<td>Flow activities are incorporated into the content by encouraging the learning of skills (forecasting share prices); having goals; receiving feedback; and, of paramount importance, the provision of enjoyable experiences. The microworld contains elements of agents, alea and user to expand the boundaries of their experience (Csikszentmihalyi, 1992).</td>
<td>To encourage flow the interactions are made as enjoyable as possible with the inclusion of humour and gaming elements to promote the feeling of play.</td>
</tr>
</tbody>
</table>
The greater the availability and accessibility of information within a learning environment, the more likely users will flounder as a result of cognitive overload and therefore fail to learn efficiently. Navigation is an important part of reducing cognitive overload, and the interface is designed so that students have a mental model of where they are in the program and can decide where to go next without having to spend time learning how to use the program. The use of quarterly intervals breaks the information into manageable chunks so that students do not feel overwhelmed with material to master at any given time. By building into the program the ability to collaborate and giving the learner control over the information flow, the cognitive load can be reduced (Stoney & Wild, 1998). The following table highlights the ways in which these two elements are specifically built into the program.

<table>
<thead>
<tr>
<th>Table 3.2</th>
<th>Integration of the attributes of Collaboration and Learner Control into the program components</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collaboration</strong></td>
<td><strong>Interaction</strong></td>
</tr>
<tr>
<td>The provision of &quot;virtual&quot; experts (experts at making good and bad decisions)</td>
<td>In order to prevent students blindly following the expert's decisions, they can only receive this type of feedback after they have moved to the next warp.</td>
</tr>
<tr>
<td>Students are allowed to choose their own paths, pace and degree of feedback. They could also choose whether or not to complete the on-line tutorials. Progressive disclosure is used to keep the amount of content within manageable bounds (Jones, 1989)</td>
<td>Learner control with coaching has been shown to be more effective than total learner control or unstructured browsing. Elements of guided discovery are therefore incorporated into the program in the form of hints and tips.</td>
</tr>
</tbody>
</table>

Curiosity, fantasy and challenge are elements which can be facilitated through gaming features in a program. The program, *Principles of Financial Investment*, is designed to encourage browsing which allows the students to satisfy their curiosity while orienting them to the program design and to new information. The scenario in which the game is embedded is designed to be realistic to the students in order to maintain ongoing motivation and the degree of difficulty is designed to increase so as to create optimal challenge throughout the program. The following table outlines these three motivational elements in terms of specific program design.
Table 3.3 Integration of the attributes of Curiosity, Fantasy and Challenge into the program components

<table>
<thead>
<tr>
<th></th>
<th>Content</th>
<th>Interaction</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Curiosity</strong></td>
<td>The content is designed to be optimally complex and inconsistencies are built in (share values didn’t always do what the theory would suggest they should)</td>
<td>The inclusion of “the time warp concept” encouraged students to wonder what would happen next</td>
<td>By providing clickable elements rather than buttons and menus, students are encouraged to explore and experience the program.</td>
</tr>
<tr>
<td><strong>Fantasy</strong></td>
<td>The learning goals are made implicit and explicit, and students are encouraged to develop their skills in forecasting share prices, thereby increasing the opportunity for an autotelic experience.</td>
<td>By making investment decisions and watching what happens with those decisions, students recognise that they are developing new competencies and skills and are meeting their personal goals.</td>
<td>The fantasy is supported by the use of a microworld to situate the students in a share investment context.</td>
</tr>
<tr>
<td><strong>Challenge</strong></td>
<td>To maintain interest, the content included elements of problem solving at an appropriate difficulty level. Students are clear on the program’s goals and are able to receive feedback when they moved to successive quarters. Although students may make technically perfect investment decisions, there is no guarantee that they will make money—such is the nature of share investment. This uncertain outcome creates interest and challenge.</td>
<td>By providing appropriate and timely feedback students are constantly aware of whether they are mastering the content and meeting the challenges.</td>
<td>The interface has elements of randomness which increases the challenge and heightens interest.</td>
</tr>
</tbody>
</table>

The program being studied is designed specifically to motivate and engage students, however, it also incorporated a framework for attending to cognitive outcomes. Implicit in the program are learning goals, cues for sifting the relevant from irrelevant information, organisation and chunking of information, and elaboration with examples and non-examples (Wager, 1997). The program is designed so that surface learning approaches of skimming, memorising and regurgitating information are not facilitated, instead active learner participation and critical learning are promoted.

**Summary**

This chapter has described the method by which an interactive multimedia microworld for teaching financial investment has been developed. The steps covered include selecting the content area, determining the learning outcomes and identifying and solving the platform and development issues. Information, interactions and interface
were all designed simultaneously, providing an holistic approach to the design, and creating a program that is realistic, authentic and visually and viscerally appealing.

The other important issues highlighted in Figure 3.1—those of implementation and support and maintenance are also taken into account in the design of the program and are discussed in Chapter 4.
Chapter Four

Program Evaluation

This chapter describes the process of evaluation during development. The evaluation method used was a soft systems methodology in that it used largely anecdotal evidence to identify problems and possible solutions. Evaluation was considered to be central to the development process as evidenced by Figure 4.1 below:

![Diagram of a development model showing evaluation as central.]

The evaluation undertaken was begun very early in the development process and was on-going until after the students used in this study had completed the program.

It was intended that the results of the various evaluation methods would be used to inform the design, rather than prescribe how it should look (Krygier, Reeves, DiBiase, & Cupp, 1997). The evaluation methods must be appropriate for the innovative nature of educational multimedia, the products of which can then be evaluated using more traditional methods (Krygier et al., 1997).

The evaluation methods were modelled on a concept described by Reeves (1992). This is a four part process that has been modified to suit the evaluation of the program in this study as illustrated in Figure 4.2 below:
This model outlines four methods of evaluation—goal refinement; documentation; formative evaluation; and impact evaluation. These four evaluation methods were used in this study during the development stage to identify and correct any problems. As shown in Figure 4.2, focus groups and surveys were used to identify issues of goal refinement; focus groups were also used to identify any problems with the documentation; the program was evaluated in the formative stages by interviewing people who had used it, focus groups, and observing students using it; and the impact of the program was measured by interviews, focus groups, surveys, observations and tests.

**Goal Refinement**

The educational goals of the program were evaluated both prior to and during the Focus Group stage through discussion and surveys. These particular focus groups took place prior to commencement of the program design. The goals were assessed both from the lecturers’ and students’ points of view. The identified goals were fundamental for informing the overall design of the program.

**Documentation**

Documentation is defined by Reeves (1992) as keeping records of “what is actually done” throughout the developmental process (p 521). Apart from the storyboards created, records were kept of emails between the development team and details of meetings were documented. These records were used to keep track of changes as
they were made, but they also allowed the team members to understand the changes that were made as a result of the different evaluation processes.

From a longer term perspective, the documentation provides a record of changes made and the reasons they were made. This can facilitate on-going evaluation, particularly if the team members were to change.

**Impact Evaluation**

Impact evaluation aimed to measure the impact of the program on student motivation, engagement and learning. Impact evaluation is usually measured quantitatively, yet as Reeves (1992) notes there are a range of evaluation methods other than those which measure quantitative learning outcomes. A range of impact evaluation methods can be more effective in measuring the impact of multimedia technologies on students. The evaluation methods used in this study covered a broad range of data gathering methods: focus groups, surveys, interviews, observations and tests.

The program was evaluated both during the design phase and during implementation. By evaluating during both of these phases, the development team could be reasonably confident that each stage of the development, and the subsequent alterations, were satisfying the needs of both the students and the lecturing staff; they could also ensure that the program ran satisfactorily as changes were made.

Once the basic program was designed, it was evaluated by a number of individuals. The rationale for the evaluation was to improve the program in any way possible, measure its effectiveness in terms of ease of navigation, and ensure that it worked. The impact of the program was also evaluated towards the end of the development process by testing whether students had achieved any learning gains after using it. The students were given a pre-, post- and delayed post-test to identify any learning gains and the results of these tests are given in Chapter 8.

The process of evaluation should be iterative and evaluating for engagement is an important component in the formula (Jacques, Preece & Carey, 1995). Engagement describes the students' "intrinsically motivated attraction and is expressed in cognitive, behavioural and affective terms" (Jacques, Preece & Carey, 1995, p 57). Due to the difficulties in measuring all three, students were asked to give their
subjective reactions. Interviews and observations are two of the methods recommended by Jacques, Preece & Carey (1995) for this. Measurement of learning outcomes will not give indications of engagement and simple time-on-task measurements may be misleading as students may be daydreaming whilst they are viewing a screen or area (Jacques, Preece & Carey, 1995).

**Formative Evaluation**

Formative evaluation encompasses all forms of evaluation which occur during the design and implementation process. In the case of this study, formative evaluation was undertaken with focus groups alpha and beta testing the program, interviews with lecturers and students to evaluate goals and needs and observations in the form of video and audio taping students using the program. Results of these evaluations were then used to identify areas for change or expansion for future versions of the program.

**Evaluation Review**

The formal evaluation reviews took the form of evaluating the information, the interactions and the interface as outlined in Figure 3.1.

The first stage of the evaluation was to have the information content reviewed by experts in the field. This involved asking two finance lecturers not connected with the program to review the content for correctness, complexity levels and completeness. Once the basic information was ratified, the next stage of the evaluation was to review the on-line tutorials for degree of appeal from a user perspective. This involved asking six finance lecturers to evaluate the tutorials by completing 12 questions on a 7 point Likert scale, there was also scope for open comments.

As can be seen, the questionnaire covered issues of interface design, such as navigation, use of animation, the structure of the program, ease of reading the text, as well as the quantity of content. As this was a review of the aesthetic appeal of the program, no reference was made to the quality of the content or the potential for learning as these aspects had been evaluated previously.

The questionnaire was designed by the development team to determine whether the framed presentation was functional and usable, whether the shockwave animations distracted the learner in any way, whether the navigation method was efficient and
effective, whether the tutorials could be scanned for important information, or whether it all had to be read, whether a hard copy version would be a useful adjunct, and whether the format itself was useful. The number of questions were limited to 12 in an attempt to have the evaluators respond quickly and without overloading them with fine detail. There was an optional 13th question which allowed the reviewer to list any strengths and weaknesses of the approach.

The four information sources were put on the world wide web, and reviewers could evaluate the tutorials

The questionnaire is included in Appendix 13.

Results of Review

The following table highlights the results of the formative review of the experts who evaluated the tutorials for user appeal. The review took the form of a seven point Lickert scale, ranging from Strongly Agree, Agree, Slightly Agree, No Effect, Slightly Disagree, Disagree, Strongly Disagree:

<table>
<thead>
<tr>
<th>Question</th>
<th>S A</th>
<th>A</th>
<th>SIA</th>
<th>N</th>
<th>SID</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  The use of an index made the structure of the document clear</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2  The animation in the top left-hand corner distracted me from the content</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3  Section headings were appropriately named</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4  The use of coloured text was effective in drawing my attention to important points</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5  I could quickly find sections that I was interested in</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6  There was too much information to be read in one sitting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>7  A hard copy of this information would have been better</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8  A hard copy would have been a useful adjunct to the materials</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9  There was too much use of bold typeface in the document</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10 I found it easy to move from place to place in the document</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11 I really enjoyed using this format</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 I would like to have more tutorials available in this format</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The reason that there was only one response for Question 2 is that four of the respondents did not have Shockwave installed and therefore couldn't see the animations.

The issue of having a hard copy did not elicit a strong reaction either way, although one respondent said that a hard copy of the questions would be useful. This may be due to the fact that people still like having a hard copy available as a security measure or for the convenience of reading away from the computer. As students are able to print as much or as little of the tutorials as they wish, it was decided to leave this issue to individual students.

Navigation was considered to be easy by all the respondents and this was also supported in the comments section. All respondents were also positive about the general format of the tutorial, even those who said that they would prefer a hard copy of the tutorial.

General typography was the main cause of criticism, with an overabundance of bold type and too much coloured type which was considered difficult to read. These problems were overcome by simplifying the type and reducing the amount of coloured type.

Four of the five respondents thought that the tutorials were an excellent supplement to the normal class contact sessions, no-one mentioned that they could replace the classes, but equally no-one said that they were of no extra value. The next stage of the evaluation process was to set up a system of heuristic evaluation to identify any problems with the interface, the information or the interactions.

**Heuristic evaluation**

Heuristic evaluation is considered to be a quick, cheap and easy evaluation method for areas such as user interface design and useability (Nielsen, 1993). Heuristic evaluation is systematic and aims to find the useability problems in the design so that they can be attended to as part of the iterative design process. It involves having a small set of evaluators examine the program and judge its compliance with a set of recognised useability and content guidelines (the "heuristics") (Nielsen, 1993).

Heuristic evaluation is almost impossible for one person to conduct and therefore groups, known as “focus groups” are established. The benefit of having groups of people evaluate a piece of software is that they are more likely to identify a greater
number of problems. Heuristic evaluation is performed by having each member of the group evaluate the interface or the content alone and then come together as a group and discuss the findings. The aggregation of the findings are recorded. It is important that when the focus group is evaluating the interface, questions they may ask about the domain they are not evaluating are answered, in order that they don’t waste time trying to solve a problem outside their area of expertise.

An example of the useability heuristics are included in Appendix 4.

The size of the focus groups is the next issue. Nielson (1993) shows the proportion of useability problems in an interface found by heuristic evaluation using various numbers of evaluators (Figure 4.3). Nielson believes that between 5 and 10 evaluators is probably optimum.

![Figure 4.3. Curve showing the proportion of useability problems in an interface found by heuristic evaluation using various numbers of evaluators (Nielson, 1993).](image)

Heuristic evaluation does not provide a systematic way to generate solutions to the useability problems or a way to assess the probable quality of any redesigns. However, because heuristic evaluation aims at explaining each observed useability problem with reference to established useability principles, it will often be fairly easy to generate a revised design according to the guidelines provided by the violated principle for good interactive systems (Nielson, 1993). Heuristic evaluation,
therefore, is a quick and easy way to evaluate a multimedia program early in its design phase.

*Principles of Financial Investment* was evaluated heuristically by setting up groups of Finance students to review the material from each of the three perspectives identified in Figure 4.1—information design, interaction design and interface design.

The general procedures for the focus groups were adapted from Patton (1990) and Nielson (1993) and the groups were conducted according to the following guidelines:

- Participants were located (between 5 and 10 per group).
- A moderator was selected (the researcher).
- A list of issues to be discussed and goals for the type of information to be gathered was prepared (see Appendix 4 for an example).
- All participants were encouraged to contribute to the discussion.
- It was ensured that the discussion was free-flowing, but a pre-planned script was prepared to overcome any interruption to the flow.
- A summary of critical comments was written.

Other issues were also considered:

- It was necessary to have more than one focus group to get a representative sample.
- The data collected was analysed for the purpose of ensuring the smooth running of the program only, rather than being statistically valid.
- One of the focus groups was conducted by the world wide web and electronic mail due to the difficulty of gathering a number of people together at one time. This focus group identified content problems and the participants were expert users rather than representative users. The limitation of this style of focus group was that participants lacked the stimulation of the group discussion, but again, due to the fact that content and aims of the program was being evaluated rather than interface or useability, it was considered that the feedback was objective.

The focus groups selected for this study were typically between six and twelve people. They participated in the program singly and were then interviewed, usually
collectively. These interviews tended to take the form of discussions to questions asked by the interviewer, with group participants able to constantly add to their comments in light of what other members of the group had to say. The object of the focus groups was to get high-quality feedback in a social context (Patton, 1990). The focus groups used for this evaluation were conducted by two people, one asked the questions and the other took notes on the responses. In this way, valuable data was able to be recorded and questioning was conducted efficiently.

The students were asked four evaluation questions based on (Reeves, 1996):

1. What happened?
   - Did the students enjoy the process?
   - Did they find the program easy to use?
   - Would they like to use more of these programs?
   - Did they feel positive about the experience?

2. How can we improve what we’re doing?
   - In terms of interface design?
   - In terms of interaction design?
   - In terms of information design

3. What learning occurred?
   - Were the concepts easy to grasp?
   - Could the students relate their learning to the real world?
   - Did the students understand the material?

4. Did the program make a difference?
   - Was the material more meaningful?
   - Did the blend of theory and practice make it more interesting

A total of 23 students broken into 4 focus groups participated in this phase of the evaluation. Of this total group, 21 of the students were overwhelmingly positive about the program, although the length of the tutorials was criticised. More than 90% of the total group were able to navigate through the program without asking for help or looking at the booklet, although most stated that they had used the on-line help and tips, and all of the students claimed to have an almost immediate understanding of the goals of the program.

The system crashed several times for some of the reviewers, particularly when they were investing, and their frustration levels were obvious, both when they were
completing their review and afterwards when they were in the focus group session. This was seen as a serious problem and the program amended to accommodate students when they pushed keys that weren't recognised by the program.

Several students found inconsistencies in the placement of clickable objects within the microworld. These objects were relocated for the next version.

These initial focus groups gave students an opportunity to have input into the design of the program and many suggestions were made, most of which were unfeasible at this point (such as having an on-line connection to the stock exchange so that real prices could be downloaded), using real stocks (liability problems could be foreseen here) and having a Bloomsberg machine to access.

Generally, the students were very helpful in suggesting minor improvements to the program and it was interesting to note that although some of them knew relatively little about interface or information design, they knew what they needed in order to learn. Many of the suggestions made by these students were incorporated into the next version of the program.

The program was then evaluated by three small groups which were composed of past Finance students and lecturers. Lecturers were selected randomly rather than being self-selecting. This was because it was felt that the lecturers who would self-select would be the “early adopters” who have been identified by Geoghegan (1994) as risk takers, more willing to experiments, generally self-sufficient, and interested in the technology itself (p 5) and would therefore embrace the technology in a fairly uncritical manner. In contrast the staff selected represented the full spectrum from “early adopters” through to mainstream lecturers who are more concerned about the teaching/learning problem being addressed rather than the technology used to address it, viewed ease of use as critical, and wanted a proven application with a low risk of failure. Spotts & Bowman (1993) lends credibility to this approach in a survey they conducted at Western Michigan University where they identified factors which were important in the adoption of instructional technology as being:
availability of equipment, reliability of equipment, improved student learning, compatibility with subject matter, advantages over traditional teaching methods, increased student interest, ease of use, training in technology use, comfort with level of technology.

The reviewers were asked to note such things as
1. Comprehension:
   Was the material easy to understand?
   Was the amount of material too much?
   Did the material have enough depth?

2. Interactivity:
   Was there enough interaction to keep the learner engaged?
   Were there enough elements of interest?
   Was navigation easy?
   Did the user feel lost at any time?

3. Appeal:
   Was the interface appealing?
   Was the treatment of the material appealing?

4. Attitude:
   Did the users enjoy using the program?
   Did the users want to return to the program?
   Would the users enjoy using more programs like this one?
   Did the users feel as though they were actually trading shares?

5. Learning:
   Was there sufficient theory to learn?
   Were there sufficient practical components to apply the theory

A Formative Review Log was also given to the reviewers so that any problems with individual screens or points on screens could be quickly and easily noted (an example is included in Appendix 3).

The groups were debriefed as in the earlier evaluation, by having two people present, one to guide the discussion and the other to take notes. These notes were then reviewed and compared and where feasible, changes made to accommodate the suggestions as follows:

1. Comprehension:
   The main concerns in this category were of lack of standard financial jargon in some sections of the program; lack of a comprehensive instruction booklet; and lack of
explanations in some areas of the program. These concerns were accommodated by incorporating the following:

- The concept of "warps" was changed to "quarters" and the hyper progression in time only became known as "warping". The six quarters were named 0 - 5, rather than 1 - 6, to fit in with financial principles.

- The instructional sheet given to students at the beginning was upgraded to a booklet to include descriptions of each screen and more information, such as the procedure for selling shares.

- The arrangement of quarters in the Economic Data section was altered to make it more obvious that some of the data was of an historical nature.

- The design of the buy and sell screen needed to be more intuitive.

- Some explanations (using voiceovers) needed to be given, for example, to explain why there was nothing in the filing cabinet drawers, or why the expert's portfolios were not available.

- Although some reviewers found using the tutorials difficult because of their lack of skills with hypertext, it was decided that most students would have had exposure to the internet and this would therefore not be a problem.

2. Interactivity:

The major concern by nearly every reviewer was the time taken to load the html files and the fact that the program was obviously exiting to Netscape to do this. Several reviewers also mentioned the fact that they had to choose where to save the data, which caused them confusion, and several wanted more options for performing a single task, for example double clicking the mouse or hitting the enter key. The following amendments to the program were made as a result of the reviews on this section:

- The notion of cross-platform compatibility was temporarily shelved and all development efforts were made with Windows 95. This enabled the html scripting to be embedded directly into Macromedia Director, rather than using the Netscape Browser. It was felt that the time it took to launch Netscape interrupted the flow of the program. Web Xtra was used to create the html script.
It was decided to have the save mechanism default to the "A" drive.

Small conventions were adopted, for example using either the "Enter" key or a mouse click to continue.

3. Appeal:

There were no suggestions on improving the interface or material treatment. All the reviewers, with one exception, enjoyed the graphics and sound effects. The one person who did not like them, wanted a 3-D rendered version to make the program look more sophisticated and therefore more marketable. This was an issue that was put aside for future consideration when more funding became available.

4. Attitudes:

There were no suggestions on ways in which to improve the enjoyment of the program, every reviewer reported that they enjoyed the interactions, sound effects, characters and situation.

5. Learning:

This was the section that drew the most criticism from the focus groups, particularly in the areas of on-line help, and the way in which the formulae were displayed on the screen. The following is a list of issues and solutions arising from this section:

- When reviewing the on-line experts' investment decisions, their portfolio would be displayed and students can access their comments by rolling their cursor over the stock. A voiceover and text box would then explain the reasons behind the investment decisions.

- The receptionist in the Broker's office was modified to give tips and hints when requested according to where students were in the program.

- The tutorials were to be completely revised. It was decided to have more, but smaller tutorials, and these would be written in the context of the available stocks. Each tutorial would be based on a different stock. The tutorials would also be available progressively as the students moved through the program, for example, in Quarter 0 only tutorial 1 would be available, but in Quarter 1, tutorials 1 and 2 would be available and so on. This was done in an effort to reduce the cognitive load on the students and also to encourage them to apply...
their learning as they went along, rather than wait until all the tutorials were completed before applying the knowledge.

- The formulas were rewritten using Microsoft Equation Editor™ to make them easier to read on the screen.

- A greater connection was made between the tutorial theory and the actual microworld. This was achieved by increasing the information given by Wanda, the on-line expert, relating it to the theory, and by having broker's retrospective reports. This also helped students understand the impact of their own investment decisions.

- The student's portfolio was changed to highlight losses and profits made between quarters, by the addition of green up arrows and red down arrows. This allowed students to instantly identify whether they had made a profit or a loss.

- In order to indicate closure an extra quarter was written in that contained no new information, but which allowed the students to review their progress over the preceding six quarters. A voiceover informed them that the trading section was finished and a video indicated trading highlights.

The final part of the formative evaluation was to give the revised program to a group of instructional design students. These students completed the Expert Review Checklist which was obtained from Georgia Institute of Technology and developed by the Multimedia in Manufacturing Education Lab (an example is included in Appendix 5). The checklist is in the form of a six point Likert scale and covers three main areas: instructional design, cosmetic design, and program functionality. The following is a breakdown of the reviewers' ratings on this checklist:
As evidenced by this table, the reviewers comments were fairly mixed in some areas. None of the twelve reviewers in this group had any knowledge of finance. However, less than half of the reviewers stated that they had a clear knowledge of the program objectives, although several of the others noted that it was obvious that the goal was to make a profit, but that there was obviously more to the program. In the debriefing they recognised the fact that they failed to note that share valuation was the main skill to be acquired, and stated that this was due to their lack of understanding of the whole content area. Seven of the reviewers decided that they couldn't assess the difficulty level due to their lack of expertise in the area, three said that it was not applicable and two felt that it was appropriate. The majority of the respondents claimed that the instructional interactions were appropriate and that the instructional design was based on sound learning theory. There was some ambivalence on the issue of feedback, with students again pointing out that they weren't sure what some of it meant. Nearly all the students were happy with the pace.

The students were more confident with the cosmetic design, although three were ambivalent on whether it followed sound principles and two did not like the colour
scheme. In the debriefing it was explained to them that the reason that a 16 bit system palette was used was so that students with low end computers could use the program as well. One student found the screen display confusing and four were undecided, again in the debriefing they explained that they did not understand some of the icons at the top of the html screens. Changes were made to the program as a result of this feedback.

The Formative Review Logs were also taken into account when upgrading the program, but the comments and suggestions were fairly minor;

- changing the position of a button,
- getting a better haircut for the newsreader in the video,
- shortcut for saving data from anywhere in program rather than having to exit to the street,
- share price movements to be animated,
- date on the calendar should be linked to the system date to prevent the program becoming obsolete too quickly,
- non-share folders separated out from share folders in the brokers office. This issue was noted but not acted upon as the finance students need to be able to sort the relevant information from the irrelevant. Once this was explained to the reviewers they understood and withdrew the comment.

The program crashed several times for some of the students. Part of this was caused by a system conflict, where two versions of Internet Explorer were resident in the computer, and there were some instances of the computers hanging due to students not following instructions. These errors were found and remedied in the next version.

All the focus groups participated in debriefing discussion sessions following their evaluation of the program. Where possible, their suggestions were incorporated in subsequent versions of the program. However, the main outcome of the focus group evaluations was that all reviewers enjoyed the basic concept of the program and its design was fundamentally correct. On the basis of this, it was decided to continue developing the program.
Focus Group Discussions

The focus groups were not given specific questions to answer, but rather were encouraged to explore issues of concern, particularly those of implementation of the program. There was much discussion generated on the future of this type of learning, with group members coming to an understanding that instruction, as they currently know it, will have to change to accommodate new methodologies and a trend away from knowledge transmission. There was some concern about learning outcomes, and it was pointed out that regurgitation of knowledge—which is an inevitable outcome of the traditional lecture series followed by examinations—will begin to disappear, to be replaced by the production of knowledge arising from relevant and realistic challenges. This problem-solving approach fits neatly within the generic skills program now being implemented within the Faculty of Business at Edith Cowan University, and all members of the focus groups lauded a program which would assist with such an approach.

Initially, there was some scepticism on the part of focus group members as to the future of multimedia-based learning in a University environment. It was felt that it is just another fad which will be short lived and that the skills and resources required to successfully implement it were lacking. Whilst these views are understandable, it is recognised that implementation of a program such as Principles of Financial Investment will require a considerable amount of staff development to allow a rethink of teaching strategies, goals and learning outcomes.

A concern regarding the novelty factor of the learning environment was expressed. It was generally agreed that students would enjoy the program for a short time before losing motivation and abandoning the program. This situational interest is of concern, but it was believed that the program would overcome the short-term novelty problem by the very nature of its environment—the fact that the motivational elements changed as students become more adept, the goals shifted and the realistic and relevant nature of the cognitive inputs made it of long-term interest to the students. Once the lecturing staff heard the students' views on how they were engaged in the program, issues of situational interest and topical interest faded. The biggest change in lecturing staff attitudes came after they had observed students using the program. They became much more positive and supportive of the entire process, making tangible suggestions for improving the program and suggesting that the whole unit receive similar treatment, rather than just a small
module. This change in attitude was also experienced by a non-Finance staff member who also had the opportunity to observe students using the program. The staff member in question immediately requested that another, similar, program be written to accommodate his content area. The program has therefore been viewed by the Faculty as a potentially important change agent in educating faculty members about the benefits of educational multimedia.

This change in attitude is documented by other educational institutions, with reports such as "mainstream faculty are most likely to use instructional technology if they see it as a solution to a particular problem they face in their teaching, rather than a 'gimmick'" (Frayer & Barner West, 1997). An important outcome of this focus group stage was the reduction in the chasm between the early adopters of the technology and the majority of the staff, which is often cited as a reason for the fact that innovation is never adopted by the mainstream (Geoghegan, 1994).

**Feedback and Evaluation for Students**

As stated earlier, the cost and complexity of identifying every possible error that students could make and trapping for those errors was too great. It was felt that by allowing students to derive their own feedback based on the quantity of money they made or lost was considerably more authentic and realistic. The ability to review portfolios from each of the completed quarters gave a sense of continuity and allowed students to view the big picture and gain a sense of their overall strategy and how good or bad that strategy was. A comparison of their own performance with that of the on-line characters was also considered to be an authentic and realistic form of feedback. An example of the benefits of the on-line characters came when a student applied the theory correctly, but still lost money. This can happen in real-life and when this particular student reviewed Wanda's comments, he was able to see why he lost money. This is a particularly important aspect of authentic instruction—the vagaries of the market are such that even investing according to the theory may cause a loss of profit.

Students completing the program did not gain any marks towards their final unit assessment, but the knowledge they gained from the program was tested in their final exam.

Although some of the students did not like finance and did not want to undertake a finance program, their interest in the learning environment seemed to increase their
efforts to master the information and maximise their investments. This has been labelled the “effin” factor (a combination of effort and interest), as it captures the positive relationship between the inherent interest the learner sees in something and the amount of effort they are willing to invest in it (Duchastel, 1996). Because the amount of effort to find the information is reduced, the students are more willing to explore and experiment.

Summary

This chapter has described the evaluation process used to refine the program in its development stages. Evaluation was conducted on the information, interactions and interface, the three key components of such a learning environment. Evaluation was conducted primarily by focus groups, although surveys, observations and interviews were also used.

Although the evaluation was designed to find minor problems such as typing errors, its main aim was to identify possible sources of exasperation that would interrupt the flow of the students using the program. As shown in this chapter, there were several items that caused problems with the reviewers and these were corrected in the next version of the program.

The focus groups and formative evaluation methods provided invaluable feedback and input during the development stage. As a result some very significant changes were made which enabled the program to function more effectively. A program of major upgrades was also developed to be completed when more grant money became available. These changes will not affect the information or learning outcomes of the program, but rather include changes such as the incorporation of wizards to make the interactions more facile.
Chapter Five

Research Methodology

This study set out to define the characteristics of adult motivation and engagement in learning, and to identify a set of guidelines for the development of engaging and motivating interactive multimedia.

A purpose-built piece of multimedia was developed which embraced these characteristics and was then implemented into an existing teaching program to determine whether such a program did motivate and engage adult learners.

This chapter outlines the methodology used to identify appropriate methods of determining whether students were motivated and engaged, how they used the program, and how the program impacted on the students' activities and cognitive engagement. In order to achieve these objectives, a review of the relevant literature was undertaken, so that a methodological plan for conducting the research could be completed.

Methodology

In order to find an appropriate method for this study, a review of the literature on research into resource-based instruction, gaming, adult learners, and motivation was conducted.

There has been a great deal of interest in the use of technology as an instructional delivery system for at least twenty years (cf. Randel, Morris, Wetzel, & Whitehill, 1992; Remus, 1981; Ross & Morrison, 1989), however much of this literature highlights inadequacies and inconsistencies in the research and there have been a number of calls for more sustained research into instructional interactive multimedia (Ferretti, 1993; Keys, 1994). In a review conducted by Dempsey, Rasmussen & Lucassen (1996), it was found that the trend in gaming literature was for discussion articles rather than research (51% discussion, 38% research) and only 2% of articles were based on development. This work aims to synthesise previous research and theory with a practical development and discussion of outcomes on motivation.
The process undertaken for this work followed Merriam’s (1989) research model of:

1. identifying a problem;
2. establishing the conceptual framework;
3. delineating the research phenomenon;
4. selecting a research methodology and using data gathering procedures and techniques; and
5. analysing data. (p 7).

The first three of Merriam’s (1989) processes have been addressed in earlier chapters, the current chapter will address the fourth process.

Philosophical Perspectives

The characteristics of qualitative research are often presented as contrasting with those of quantitative research (Lincoln & Guba, 1985). Kaplan & Maxwell (1994) argue that the goal of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified. Qualitative research is viewed as a process of inquiry building an holistic, complex understanding of a problem which was developed to study social and cultural phenomena. Following is a general overview of qualitative research, including philosophical perspectives on the methodology.

Data Gathering Methods

In order to select a research methodology for this study, a substantial literature review was undertaken. Merriam (1989) divides educational research into three main styles—positivist (quantitative); interpretive (qualitative) and critical (action research). Guba (1981) states that in selecting a methodology one should choose a model appropriate to the ‘phenomenon being investigated’ (p 76). This notion is supported by Merriam (1989) who states that “The selection of a methodology depends upon the source of knowledge being accessed and the assumptions underlying the nature of research” (p 9). In spite of the three styles of educational research expounded by Merriam (1989), most research is divided into either qualitative or quantitative, and there is an assumption that a researcher will choose one or the other.
Before discussing the differences between qualitative and quantitative methodologies, the foundational similarities must be considered; the first is that all qualitative data can be measured and coded using qualitative methods; and, quantitative research can be generated from qualitative enquiries. However, there are also foundational differences, the major one of which stems from the underlying strategies of the researcher; qualitative research is exploratory and inductive whereas quantitative research is deductive and conformatory (Trochim, 1997).

As Patton (1990) states “Considering evaluation design alternatives leads directly to consideration of the relative strengths and weaknesses of qualitative and quantitative data. Qualitative methods permit the evaluator to study selected issues in depth and detail. Quantitative methods...require the use of standardised measures so that the varying perspectives and experiences of people can be fit into a limited number of predetermined responses...” (p13). Quantitative will give a much more generalisable picture of the problem, whereas qualitative will increase the understanding of the problem. Patton (1990) discusses the fact that qualitative and quantitative research are not mutually exclusive and that both types of research can be conducted within the same study, thus overcoming the weaknesses inherent in each. Using both research paradigms negates, in part, the debate polarising the two (Campbell & Stanley, 1966; Guba, 1981) and is a considered option by such researchers as LeCompte (1993), Merriam (1989) and Patton (1990) who all believe that research method should be appropriate to the cohort group and type of information desired. However, there is a theory that the two approaches should be considered complementary rather than competitive (Pope, 1995).

Salomon (1991) believes that the qualitative/quantitative debate is not constructive and that instead, research should be categorised into analytic or systemic. Reeves expands on this view, stating that qualitative and quantitative research may be complementary, but that qualitative should precede quantitative by identifying meaningful learning theory and then applying quantitative research methods to the findings (Reeves, 1993). However, he cautions against qualitative research unless it is properly conceived and rigorously applied (Reeves, 1993, p44). He defines four categories of research which constitute problems—definitional problems; theoretical problems; methodological problems; and analytical problems. These problems manifest themselves in the lack of a
Chapter 5 Methodology

sound theoretical framework, poor literature reviews, inadequate sample sizes and large attrition rates, infrequent and brief treatments, inadequate interpretation and meaningless discussion of results (Reeves, 1993; Reeves, 1995).

However, qualitative and quantitative research are not necessarily mutually exclusive with good examples of them being combined (triangulation) being found in Kaplan & Duchon (1988) and Lee & Caffarella (1994).

Qualitative research is a term meaning different things to different researchers and represents a variety of methods, rather than a single approach. Qualitative research methods are designed to help researchers understand the people being studied, what they think and feel, and the social and cultural contexts in which they live (Myers, 1997).

The four main research methods discussed in the methodology literature are action research, case study research, ethnography and grounded theory. The way in which data is collected is influenced by the research method selected (Myers, 1997). Table 5.1 gives an overview of these four main qualitative research methods.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description &amp; Uses</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Action Research</td>
<td>Used to solve specific problems in applied settings. The research problem arises from events disturbing the researcher, and the problem is stated in a general way (Merriam, 1989). Action research is often used to identify the means by which change can be created.</td>
<td>The method is relevant to an actual situation and focuses on a process for problem solving and project development.</td>
<td>Lacks internal and external controls, generalisability of results are therefore limited to the specific conditions under which the study was done (Merriam, 1989).</td>
</tr>
<tr>
<td>Case study research</td>
<td>Investigates a phenomenon within its real-life context. Useful for identifying organisational rather than technical issues and can be used in a variety of fields. &quot;An intensive description and analysis of a particular social unit that seeks to uncover the interplay of significant factors that is characteristic of that unit&quot; (Merriam, 1989:190).</td>
<td>Useful for exploring a field of practice not well researched. In-depth descriptions are needed before generalisations can be made. Case study can result in conceptualisations of the phenomenon useful for guiding future studies (Merriam, 1989).</td>
<td>Can be expensive and time consuming. Interviewers and observers need to be trained, and findings cannot be generalised to other areas. Case study write-ups tend to be long in order to accommodate the &quot;thick&quot; description.</td>
</tr>
<tr>
<td>Ethnography</td>
<td>Emphasises the observation of details of everyday life as they naturally unfold. Method of describing a culture or society (Trochim, 1997).</td>
<td></td>
<td>Some critics consider grounded theory to be undisciplined and impressionistic. Success depends on analytical powers of the investigator (Merriam, 1989). Other investigators may conclude differently with the same data.</td>
</tr>
<tr>
<td>Grounded Theory</td>
<td>Refers to an inductive process of generating theory from data, sometimes called &quot;ground up&quot; processing. Incorporates deductive reasoning when using constant comparisons. Patterns in observations are detected and working hypotheses created (Trochim)</td>
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</table>

A researcher using qualitative research methods employs an "insider's perspective" and the style is often subjective. The qualitative researcher studies things in their natural settings and attempts to understand the subjects' view of the world. In contrast, quantitative approaches to research seek to predict, show causality or to generalise
findings to other populations (Campbell, 1966). The researcher remains detached to avoid contaminating the data and the methods are generally deductive and reduce data to numbers.

When deciding what to omit and what to include from any of these methods, note should be taken of Patton's description of the balance between description and interpretation:

*Description and quotation are the essential ingredients of qualitative enquiry. Sufficient description and direct quotations should be included to allow the reader to enter into the situation and thoughts of the people represented in the report. Yet the description must not be so thin as to remove context or meaning. Qualitative analysis presents "thick description"* (Patton, 1990).

Thick description is described by Denzin (quoted in Patton, 1990:430) as going beyond a mere description, but presents detail and context. The description allows the reader to interpret what has been said or seen.

The descriptive method is one of the most commonly used with adult learners, as this method is able to accurately describe facts and characteristics of a given population (Merriam, 1989, p.58). Descriptive methodology concerns itself with describing what has happened rather than predicting what will happen, and is appropriate when the central focus of the research is to examine facts about people, their opinions and attitudes (Kerlinger, 1986). Descriptive research helps to identify the degree to which two events or phenomena are related.

The way data are sampled is of great importance in descriptive research, and usually three different procedures are used to gather data—cross-sectional, longitudinal and cross-sequential sampling.

Cross sectional sampling is where data are gathered at a single point in time, longitudinal is over a period of time, and cross sequential is a combination of the two (Merriam, 1989). The most common technique used for gathering data in descriptive research is the survey—questionnaires and interviews (p 62).
Questionnaires are used to carefully sequence and validate questions, and interviews provide in-depth information. Structured observation is used to gather data about the performance and interaction of people.

Although descriptive research is the most common form of research in adult education, it has strengths and weaknesses (Merriam, 1989). Its strengths are that it is easy to use, and produces data that are accurate and representative. It allows the researcher to study relationships or events as they happen in human life situations, and allows for exploration and identification of new variables. One of its limitations is that it lacks the ability to predict, hence the need to supplement with quantitative procedures if prediction is an important part of the research.

Another means of evaluating educational multimedia is the evaluation study. Evaluation studies describe the effectiveness of a particular program or method, usually in an applied setting (Reeves, 1995). The difference between evaluation and research lies in the ‘questions asked, not the methods used as the methods in each are essentially the same (Merriam, 1989). Evaluation research collects data or evidence on the worth or value of a program, process or technique. Its main purpose is to establish a basis for decision making’ (Ibid). A review over five years of Educational Technology, Research and Development by Reeves (1995) shows that both developmental and evaluation research were conducted via qualitative methods, with some mixed methods, and that a review of Journal of Computer Based Instruction over a period of five years, showed only two developmental studies using mixed methods and seven evaluation studies using quantitative, four using qualitative and 23 using mixed method.

Not all of the available methods of gathering information have to be considered for every study. Preliminary evaluation of the problem serves to eliminate many from consideration at the outset (Baumgarten, 1986). However, it is important that whatever method is chosen, the results can be validated in some way. Triangulation of data is one means of doing this. Triangulation has been defined as “the combination of methodologies in the study of the same phenomenon” (Denzin, 1978). The advantage of triangulation is that it gives multiple perspectives on a given problem; it can provide a richer, contextual basis for interpretation and it can also provide cross validation of the data (Jick, 1979) Triangulation can also capture a more holistic overview of the data.
being studied, and is promoted as a research method which capitalises on the strengths of a particular method and compensates for weaknesses in another. However, this may not be the case and triangulation may, in fact, compound the weaknesses. In spite of this danger, researchers are encouraged to combine different approaches in their research, as triangulation can instil confidence in results (Jick, 1979), although replication of studies can be difficult. There are two main types of triangulation, the "across methods" type which is used when two or more methods are congruent and give comparable data (Denzin, 1978); and the "within-method" type which uses multiple techniques within a method to collect and interpret data (Denzin, 1978).

The use of qualitative research has been steadily growing over the last decade and one of the most prominent methodologies is survey research, used to capture data from organisations (such as businesses or educational institutions) (Grover, 1997). However, surveys must be carefully designed and appropriately implemented. Survey research is usually quantifiable, requiring standardised information to describe variables or to study the relationships between variables, and the information is gathered via a sample, a fraction of a given population, with the need to generalise findings from the sample across the whole population (Grover, 1997).

**Survey Research**

There are two major types of survey research—exploratory and explanatory (Kerlinger, 1986). Exploratory enables the researcher to become more familiar with the topic and is useful, for example, for identifying strengths and weaknesses of a given multimedia program, results can then be refined to identify new possibilities (Grover, 1997).

Explanatory research finds causal relationships among variables. For example it can explain, hypothesise and test for positive (or negative) relationships. Results are then interpreted and contributed to theory development (Grover, 1997).

The preparation of objectives for the survey is perhaps the most important step in designing a survey questionnaire. According to Baumgarten, (1986) there are two general cautions to be made about preparing survey objectives: "survey objectives are not necessarily as broad as overall information needs; survey objectives should never be stated in terms of gathering information" (p 8). Generally the problem will have a wider
range of topics and considerations than the survey, which means that other techniques should be used in conjunction with the survey to cover the other aspects. One method of stating objectives effectively is to determine the nature of the conclusions desired (Baumgarten, 1986). The determination of objectives is often an iterative process, in which some objectives are stated, evaluated and chosen, examined for feasibility, operationalised in a draft survey instrument, then restated and re-evaluated until a final set is determined. After preparing the objectives the following six items should be considered as part of the general plan for the survey:

- The content of the survey needs to be determined. There is generally not a straightforward transfer of objectives into questions for a questionnaire, but a logical development of different aspects of the plan so that questions are translated from general statements into operational descriptions of the data required (Baumgarten, 1986).

- The population to be surveyed needs to be specifically defined (Baumgarten, 1989).

- The size of the survey needs to be defined. According to Patton (1990) "there are no rules for sample size in qualitative inquiry". The size is determined by the purpose of the study, the accuracy and confidence level required, the complexity of the information, the depth of the study, and time and budget considerations (Baumgarten, 1986; Patton, 1990). Due to the constraints of time and budget, nine students were selected for the in-depth study.

- The collection methods need to be determined. Five factors are involved in the choice of collection methods: the expected response rate; the cost; the accuracy required; the complexity of the information; speed with which answers must be obtained (Baumgarten, 1986). Generally higher response rates and more complex information can be obtained with interviews than with self-administered questionnaires (Patton, 1990), but costs increase with personal contact (Baumgarten, 1986) so there may have to be a trade-off between objectives and costs. (Marshall & Rossman, 1995) provide a comprehensive list of data collection methods together with their relative strengths and weaknesses. The primary data sources are those which include an interview of some description, observation, and/or document or artefact collections (such as questionnaires or survey forms). With any method there are both advantages and
disadvantages associated with the various forms of data collection. Interviews allow the researcher to collect large amounts of contextual data quickly, but the data are open to misinterpretation due to cultural differences (Bier, Gallo, Nucklos, Sherblom, & Pennick, 1996-1997).

- To increase efficiency, a draft plan can be drawn up which states the specific survey objectives, alternatives and considerations which have to be made to make a decision, and estimates of timing (Baumgarten, 1986).

- The sampling procedure is one of the most critical elements of a qualitative study. The sample frame must include elements that should be part of the population and exclude those that should not.

In order to select a methodology for this study, alternatives were considered and either adopted or rejected on practical as well as academic grounds.

**Methodological Plan**

One of the main tasks for this research was not only selecting the methodological approach but also selecting the techniques for data collection (Merriam, 1989).

Following on from the review of various methodologies, it was decided that the methodology used for this study would be qualitative as the researcher wished to understand the thoughts and feelings of the participants in the study in order to determine whether they were motivated and engaged and what it was that contributed to the motivation and engagement.

After some consideration of the four research methods described in Table 5.1, Action Research was deemed to be the most appropriate, but there were considered to be some areas of the research which would respond well to the Grounded Theory approach. Using a mixture of the two approaches was therefore judged to be suitable, as current research in multimedia over the last few years is beginning to mirror that of information systems, in that a diversity of methods is being applied (Grover, 1997). Data gathered using action research and grounded theory contains the "thick description" identified by Patton (1990) as being appropriate when the research is more concerned with process than with the specific outcomes or products (Campbell, 1996). This study also sought to incorporate descriptive research with cross-sequential sampling. As stated earlier,
descriptive research has been shown to be appropriate when facts about people, attitudes and opinions are sought (Kerlinger, 1986), and cross-sequential sampling was an appropriate method to gather the data at different points in time. Incorporation of both types of research allowed the findings to be triangulated, a technique which has been endorsed by several researchers (eg. Jick, 1979; Kaplan & Maxwell, 1988).

The study did not concern itself with whether multimedia was able to motivate adult learners better than other media, but rather whether adults were motivated to use and are engaged by a multimedia program which had been specifically designed to appeal to the affective domain. A comparison of learning in a traditional setting with learning using multimedia would not give valid results due to the effects of intrinsic properties of the treatments (Ross & Morrison, 1989). The Cognition and Technology Group at Vanderbilt (1993) concur, stating that:

> If the “traditional instruction” that is provided is of especially poor quality, and if tests are more aligned with instruction in one’s experimental group than one’s control group, it is often less-than-illuminating to show that one group of students performed better than the control group. (p 59).

The study therefore, did not have comparative elements, rather, it was concerned with identifying whether students were motivated to use and keep using the program, whether they were engaged with the content when they were using it, how they used it, and whether they achieved any learning gains.

It was determined that the data gathered would be by interview, observation, analysis of talk, and pre-, post- and delayed post-testing of students. This would provide data triangulation, providing the means of determining in what ways the program motivated and engaged the students, and how they used the program, as well as validating the results of the data.

The survey population was determined to be students who were either currently enrolled in the finance program, or who had completed some finance theory. Twelve students were selected for the study, divided into two groups—four students to work independently and eight students divided into pairs to collaborate. Twelve students were considered to be the optimum number given the time constraints being experienced and the amount of data to be gathered and analysed. An attempt was made
to sample students of both genders, a wide variation in age and cultural groups. A purposeful attempt was made to incorporate older students of both genders as their attitudes towards computers generally, and multimedia specifically, may have been different from the younger students.

**Data collection**

The data was collected in two main stages—a pilot study and a main study. The pilot study was completed by three students using the program simultaneously, but the students participating in the main study came at different times. This overcame the threat of mono-operation bias (Cook & Campbell, 1979), which is discussed later in this chapter.

**Pilot Study**

A pilot study was conducted with three students purposefully selected (Patton, 1990) from a first year class of students studying introductory finance in a Business Faculty, and who had not previously covered any of the theory. These students were given the program in lieu of 2 weeks of normal 3-hour workshop classes. Students were observed during their free use of the program, and were subsequently interviewed and a questionnaire administered to determine ease of use, functionality and time on task. A pre- and post-test was also administered. A delayed post-test was given six weeks after the three students had completed the program to identify to what extent they had retained the knowledge gained during the program.

The aim of the pilot study was to ensure that the program ran effectively over a computer network and that the students could complete the tasks set in the microworld with a minimum of intervention on the part of the lecturer. The pilot study was also used to fine tune any content and to identify any elements which may have been missing from the program. It was also used to refine the data gathering techniques and methods.

**Main Study**

The main study was conducted over three weeks with nine students—purposefully selected for an in-depth study from a large group of finance students—completing the
program. The students were selected to accommodate a range of learning styles, age groups, cultural backgrounds, previous experience and range of abilities. The nine students were divided into two groups—3 students to work independently and 6 students divided into dyads to collaborate. The students were observed, interviewed and material was also gathered from videos to track student using the program, time in various sections and amount of help requested. Data from the videos showed how the students navigated through the program; what sections they used; what sections they didn’t use; what sections they liked; how calculating they were in their movements through the program; how long they spent in each section; how well they used the competitive elements; how well they used the tutorial elements; levels of co-operation (for those using program collaboratively); and how often they repeated sections. Collaborating pairs were video and audio taped to investigate their talk for lower order thinking, higher order thinking and off-task activities.

The students were profiled to determine their age, gender, cultural background, prior knowledge and learning styles. Kolb’s Learning Styles Inventory (LSI) was administered to determine the learning styles of the students. Although this information was collected, much of it wasn’t used in this study as the sample size was too small to measure anything meaningful. The information will, however, be put towards another study where an emphasis is placed on individual differences.

The next section of this chapter describes the main methods of gathering the data and where each method fitted into the methodological plan.

Interviews

Interviews with students were conducted in order to corroborate data obtained from the questionnaires and observations of the students. It was decided to use a standardised, open-ended interview to ensure that each participant was asked the same questions. Flexibility was built-in with probe questions where necessary. This form of interview also makes data-analysis easier as each participant’s answer to a particular question is easy to locate, and similar answers are easy to group together (Patton, 1990). Issues of moderation between interviewers were irrelevant in this study as there was only one interviewer.
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The interview was designed to have a high number of open-ended questions. The distinction between open-ended and closed-ended questions concerns the degree of freedom accorded the participant in choosing the answer (Baumgarten, 1986). Open-ended questions allows the participants to generate responses in their own words, whereas closed-ended questions restricts them to choosing among alternatives specified by the survey designer (Patton, 1990; Merriam, 1989).

Participants were encouraged to respond in their own words and probes were used where necessary to overcome the inherent weakness of lack of flexibility of standardised interviews. The questions were carefully worded to avoid putting words into the participant’s mouths and allow them to express themselves freely (Patton, 1990).

The interview was divided into five categories of questions as outlined by Patton (1990) as follows:

| Table 5.2. The five question groups as asked in the interview (from Patton, 1990) |
|---------------------------------|------------------------------------------------------------------------------------------------------------------|
| Demographic/Background Questions | These allowed the interviewer to determine the age, cultural background, gender, previous experience and educational background of the participant. |
| Opinion/Value Questions         | These questions tell the interviewer what the participants think about issues. They elicit “goals, intentions, desires and values” (Patton, 1990). |
| Experience/Behaviour Questions  | These questions highlight the observable experiences and behaviours of the participants and allow them to describe their experience of an event or program. |
| Feeling Questions               | The aim of these questions is to gain an understanding of the emotions experienced by participants during a program or event. The response should contain adjectives such as “happy, bored, frustrated, interested” etc. The response should not be analytical, interpretive or contain an opinion. Feeling questions should contain the word “feel” rather than the word “think”. |
| Sensory Questions               | These questions are asked to determine the degree of immersion a participant has in an event or program. |

The following is a copy of the interview questions with a rationale for each question asked. The complete interview questionnaire in included in Appendix 14.
The purpose of the next few questions is to get your thoughts and feelings on the actual program.

<table>
<thead>
<tr>
<th>Question Rationale</th>
<th>Question Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>7</strong>  What did you feel when you were told you were going to use the program?</td>
<td>A feeling question to get a starting attitude towards multimedia and computer learning</td>
</tr>
<tr>
<td><strong>8</strong>  What did you feel after you had used the program?</td>
<td>A feeling question to determine whether there had been a shift in attitude.</td>
</tr>
<tr>
<td><strong>9</strong>  When you started the program, what did you want to get from it?</td>
<td>To see whether the students had any goals in mind when they started, whether they had thought about what they might get from such a program.</td>
</tr>
<tr>
<td><strong>10</strong> Did you achieve your goals. If not, why not?</td>
<td>To see whether students felt satisfied with what they achieved, and if not, why not.</td>
</tr>
<tr>
<td><strong>11</strong> How would you feel if you were asked to use more programs like this?</td>
<td>To see how students would react to using multimedia programs in their general education.</td>
</tr>
<tr>
<td><strong>12</strong> When you first used the program, how did you find your way around?</td>
<td>To determine whether navigation was easy and intuitive.</td>
</tr>
<tr>
<td><strong>13</strong> How did you feel about having to find your own way round the program?</td>
<td>To see how students felt about having some learner control as against system control</td>
</tr>
<tr>
<td><strong>14</strong> Did you ever feel lost?</td>
<td>To determine whether students had formed mental models of the program &quot;map&quot;.</td>
</tr>
<tr>
<td><strong>15</strong> What were the strengths of the program?</td>
<td>This is a presupposition question to allow students to consider strengths.</td>
</tr>
<tr>
<td><strong>16</strong> What were the weaknesses of the program?</td>
<td>This is a presupposition question to allow students to consider weaknesses.</td>
</tr>
<tr>
<td><strong>17</strong> What would you like changed or added?</td>
<td>This is a presupposition question to allow students to consider whether something should be changed or added.</td>
</tr>
<tr>
<td><strong>18</strong> With the benefit of hindsight, how would you approach using the program if you were starting afresh?</td>
<td>This open ended question allows the students to consider different approaches to the program which might benefit future users.</td>
</tr>
</tbody>
</table>

141
This next section asks more specific questions about the program

<table>
<thead>
<tr>
<th>Immersion</th>
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</tr>
</thead>
<tbody>
<tr>
<td>19  The program attempted to put making investment decisions into a real-life context. What did you think about this context?</td>
<td>Open-ended question to determine whether students felt the context was realistic.</td>
</tr>
<tr>
<td>20  Did you have a feeling of experiencing the program or of using it?</td>
<td>A sensory, closed-ended question to determine degree of immersion.</td>
</tr>
<tr>
<td>21  What did you really like about the learning environment?</td>
<td>Presupposition question to allow students to reflect on what they liked.</td>
</tr>
<tr>
<td>22  What did you really dislike about the learning environment?</td>
<td>Presupposition question to allow students to reflect on what they disliked.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reflection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>23  How did you decide where to go next in the program?</td>
<td>Open ended question to provoke students in revealing whether they reflected on their next move or used a browsing mode.</td>
</tr>
<tr>
<td>24  How did the program enable you to reflect on your learning as you completed the activity?</td>
<td>Open ended question to see whether students felt the program encouraged them to think about what they had done and why.</td>
</tr>
<tr>
<td>25  Did you feel you had sufficient time to think about what you were doing and why you were doing it?</td>
<td>Open ended question to see whether students felt under any pressure to finish the program.</td>
</tr>
<tr>
<td>26  What did you think about being able to compare your performance with that of an expert?</td>
<td>Open ended question to see whether students used the expert.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow/Feelings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>27  How much did you learn from the experts' performances?</td>
<td>Open ended question to see whether students felt expert feedback was useful for learning and feedback on their own performance.</td>
</tr>
<tr>
<td>28  How much did the design of the learning environment help your progress?</td>
<td>Presupposition question to determine whether the design was helpful to learning.</td>
</tr>
<tr>
<td>29  How much did the design of the learning environment hinder your progress?</td>
<td>Presupposition question to determine whether the design was a hindrance to learning.</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>Methodology</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>30</td>
<td><strong>What emotions did you feel when using the program, e.g. bored, frustrated, enjoyment, happy, surprise, contented, etc?</strong></td>
</tr>
<tr>
<td>31</td>
<td><strong>How did you feel about the amount of information presented to you at any one time?</strong></td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td><strong>Did you work by yourself on the program?</strong></td>
</tr>
<tr>
<td>33</td>
<td><strong>If yes, how would you have felt if you had had a partner to work with you?</strong></td>
</tr>
<tr>
<td>34</td>
<td><strong>If no, how did you feel about sharing the learning with a partner?</strong></td>
</tr>
<tr>
<td>35</td>
<td><strong>Did you discuss your learning with friends at any time? Why?</strong></td>
</tr>
<tr>
<td><strong>Learner Control</strong></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td><strong>How did you feel about working at your own pace?</strong></td>
</tr>
<tr>
<td>37</td>
<td><strong>How did you feel about choosing where to go in the program?</strong></td>
</tr>
<tr>
<td>38</td>
<td><strong>How did you feel about having hints and tips available when you wanted them?</strong></td>
</tr>
<tr>
<td>39</td>
<td><strong>How did you feel about the level of hints and tips dropping as you worked through the program?</strong></td>
</tr>
<tr>
<td><strong>Curiosity</strong></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td><strong>Were you keen to see what happened next?</strong></td>
</tr>
<tr>
<td>41</td>
<td><strong>How did you feel about having surprise elements in the program?</strong></td>
</tr>
<tr>
<td></td>
<td>Fantasy</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>42</td>
<td>How did you feel about stretching the limits of your experience?</td>
</tr>
<tr>
<td>43</td>
<td>How did you feel about being able to forecast share prices?</td>
</tr>
<tr>
<td>44</td>
<td>What did you feel about the level of difficulty of the program?</td>
</tr>
<tr>
<td>45</td>
<td>How did you feel about being able to learn from the experts and apply that learning?</td>
</tr>
<tr>
<td>46</td>
<td>How did you feel about applying what you learned from the on-line tutorials?</td>
</tr>
<tr>
<td>47</td>
<td>How did you feel about being able to buy the tutorials on-line?</td>
</tr>
<tr>
<td>48</td>
<td>Did you find the program challenging?</td>
</tr>
<tr>
<td></td>
<td>If not, why?</td>
</tr>
<tr>
<td>49</td>
<td>Did you find the program motivating?</td>
</tr>
<tr>
<td></td>
<td>If not, why?</td>
</tr>
<tr>
<td>50</td>
<td>Do you have any other thoughts or feelings about using this package?</td>
</tr>
<tr>
<td>51</td>
<td>What advice would you give to a student deciding whether to complete the package?</td>
</tr>
<tr>
<td>52</td>
<td>Would you like to complete more packages of this nature?</td>
</tr>
</tbody>
</table>
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Observation

Observation is a useful adjunct to interviews as interviewees are often unaware of their behaviour and the observations allow the researcher to put responses into context. It is also a flexible method, allowing the researcher to be "...open, discovery oriented and inductive in approach." (Patton, 1990). Observation also facilitates documentation of events such as time-on-task, time-off-task and collaboration, events which may be unconscious to the participants, it also allows the researcher to track movements and see difficulties which participants may be unwilling to articulate in an interview.

However, observation does have some limitations, namely the amount of activity that can be observed at any one time, and the fact that the events occurring may be unpredictable and difficult to forecast (Merriam, 1989).

As with other data gathering methods, observations need to be carefully planned and prepared to fit the particular research problem and the following questions should be asked prior to embarking on the observation:

1. What should be observed?
2. How should the observation be recorded?
3. What procedures should be used to ensure accuracy of observations?
4. What relationship should exist between the observer and observed and how should that relationship be established?

(Selltiz, 1959) (p. 205).

There are a number of observation methods and, as with other research techniques, the chosen method should be appropriate to the data being gathered (Patton, 1990). The following (Table 5.3) is adapted from Merriam (1989, p 148) and summarises the various techniques for gathering data by observation:
Table 5.3. Summary of techniques for data gathering by observation (based on Merriam, 1989)

<table>
<thead>
<tr>
<th>Type</th>
<th>Uses</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checklists</td>
<td>In structured observations to document and itemise behaviours, events and conditions.</td>
<td>Data reliability between observers. Easily coded and analysed.</td>
<td>Observer training, limited to items on checklist.</td>
</tr>
<tr>
<td>Rating Scales</td>
<td>In structured observations to assess degree to which condition or behaviour is present. Only one alternative chosen.</td>
<td>Indicates degrees of value of observation, therefore considered to be more discriminating.</td>
<td>Intense and accurate observations with training required. Errors can occur such as generosity, severity and errors of central tendency (avoiding extremes).</td>
</tr>
<tr>
<td>Content Analysis</td>
<td>Documentation and quantitative analysis of aural, visual and printed media.</td>
<td>No real time constraints enabling the observers to work at their own pace.</td>
<td>Can only interpret the material being analysed.</td>
</tr>
<tr>
<td>Unobtrusive Observation</td>
<td>A form of unstructured observation where the participants don’t know they are being observed, and allows systematic observation of patterns of behaviour or events.</td>
<td>More likely to capture what is really happening than when participants are aware they are being observed.</td>
<td>Does have some ethical concerns.</td>
</tr>
<tr>
<td>Participant Observation</td>
<td>Unstructured observation which allows a comprehensive investigation of events or behaviour.</td>
<td>Allows observer to understand behaviour and events as an insider whilst describing them for an outsider (Patton, 1990).</td>
<td>Requires training, is time consuming and presence of the researcher may influence the responses of the participants.</td>
</tr>
</tbody>
</table>

After careful consideration the unobtrusive method of observation was adopted but with a semi-structured checklist of observable behaviours. The ethical considerations were not considered to be of paramount importance as the students already knew they were being video-taped. The observation was to be a back-up system for the videotaping and audio-taping and was not, therefore, a primary data collection method.

Video-taping the participants actually using the program, allowed the researcher to track accurately elements such as time-on-task, collaborative elements and paths through the program. Video cameras were set up behind each of the computers allowing the monitors to be observed but not the students. Any non-verbal behaviours on the part of the students were able to be recorded by the observer. The audio-taping of student interactions allowed the researcher to listen to conversations to ascertain whether there were any difficulties with understanding any aspects of the program and also to corroborate elements such as time on task, so that if the student spend a lot of time looking at one screen, the voiceover could help determine whether that student was
actually engaged with the screen or chatting to friends. To overcome any ethical problems students were made aware of the fact that their voices were being recorded.

**Measurement and Validity**

Many of the things being measured by qualitative research are intangible; such as attitudes, behaviours and emotions. Validity is an element of research which addresses the issue of whether what the researcher says is being measured, is in fact being measured (Rymarchyk, 1996). In more conventional paradigms, researchers looked for validity, generalisability, reliability, replicability and objectivity, but in naturalistic paradigms they seek credibility, transferability, dependability and confirmability (Lincoln & Guba, 1990). One technique for establishing credibility is triangulation, and transferability of the findings rests on “thick” description (Patton, 1990). Dependability and confirmability are achieved through the use of an audit, where the steps of the research are verified through examination of the raw data, data reduction techniques and the research notes (Lincoln & Guba, 1990). The audit can be based on the four components of validity: face validity, content validity, criterion validity and construct validity.

Face validity is the simplest measure and is relevant to the construct to a person disconnected with the study. The individual checking the validity should be similar to the target audience and should be able to state whether the survey adequately and completely assesses someone’s attitude (Rymarchyk, 1996).

Content validity takes face validity one step further, and experts in the field are asked to check the validity of the construct. The experts may be aware of nuances which a layperson would not be aware of.

Criterion validity is more rigorous than either face or content validity and means the assessment can predict or agree with constructs external to attitude (Rymarchyk, 1996). They are both estimated through comparing performance with some criterion external to the test. Predictive validity allows the survey to forecast short or long-term outcomes. Concurrent validity estimates the degree to which the rating agrees with the achievement (Merriam, 1989).
Construct validity means that the scores produced in the survey correlate with other related constructs in the anticipated manner. This is the most rigorous validity test and is established by most logical and empirical means (Merriam, 1989).

Constructs are abstract, not able to be directly observed, and are not considered actual behaviours or events. Construct validity is first estimated logically by how well the various attributes or characteristics represent the particular construct (Merriam, 1989).

Construct validity refers to the degree to which inferences can be made from operationalisations in a study to the theoretical constructs on which they were based (Trochim, 1997).

When creating a valid research model, the threats to that model must be thought through prior to implementation of the study to ensure that the measures reflect what was intended. One way of checking constructs is to have experts to critique them to check that the construct has been operationally defined properly. Another threat is that of mono-operation bias, where only one treatment is given and the results might not be generalisable to other treatments (Cook & Campbell, 1979). This is easily overcome by implementing multiple versions of the study. Mono-method bias is a similar threat, but applies to the measures or observations, rather than programs. A solution to mono-method bias is to implement multiple measures of key constructs in order to demonstrate that the measures behave as expected over a number of instruments (Cook & Campbell, 1979).

The interaction of different treatments is another threat which must be addressed in any qualitative study. If students are receiving other, similar, instruction, then that may confound the ability to determine the extent of the effectiveness of the program being studied. The fact that participants know that they are taking part in a study may be a threat to the validity of that study, and the testing becomes part of the treatment and is inseparable from the effect of the treatment. This is a concern to the construct validity because the label “program” should relate to the program alone, but will in fact, include the testing (Cook & Campbell, 1979).

There are also the social threats to construct validity to be taken into account. Students will try to work out why they are being tested and behave accordingly. This is a threat because they may increase their participation as a result of the testing, rather than the
program and the outcome cannot be attributed to the program alone. One solution to this problem is to keep the purpose of the testing from the students. The researcher needs to mask any emotion to responses so that students do not get verbal or non-verbal cues as to whether their answers are meeting the expectations of the researcher (Cook & Campbell, 1979).

Internal validity is also important to take into account when assessing the impact of a particular study or intervention. Internal validity is relevant only to a specific study and cannot be generalised across other studies. It means that the evidence of the intervention showed that the outcome did happen, but that the intervention did not necessarily cause the outcome—this is construct validity (Trochim, 1997).

The following table outlines the methods by which validity and reliability were attained for this study.

<table>
<thead>
<tr>
<th>Component</th>
<th>Method of attaining validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Validity</td>
<td>Before administering the interview to the students who participated in the study, the validity of the questions were checked with two other students who had been part of one of the initial focus groups. By checking the interview questions with people who had seen the program, it was possible to project that the results would be believable and the data gathered reasonable (Patton, 1990).</td>
</tr>
<tr>
<td>Content Validity</td>
<td>Content validity represents the extent to which the items on the instrument match the behaviour, skill or effect the researcher intends them to measure. Judgement is performed through a critical review of the instrument to determine how representative sample items are (Merriam, 1989), and therefore content validity requires that experts in the field validate the data collection method. The interview questions were therefore also verified with lecturers and experts from the focus groups.</td>
</tr>
<tr>
<td>Criterion Validity</td>
<td>Criterion validity is a form of content validity and is estimated through comparing performance with a criterion external to the test (Merriam, 1989). In this study, performance was compared with the way students felt before and after completing the program.</td>
</tr>
<tr>
<td>Construct Validity</td>
<td>One way of ensuring that instruments measure what they intended is to build in construct validity. Again, in this study, experts from the focus groups checked the instruments, and also the study was carried out over several separate sessions to avoid mono-method bias. An attempt was made to avoid social threats to validity by keeping the purpose of the test from the participants. They were urged to be critical if necessary and positive and negative feedback to comments was not given.</td>
</tr>
</tbody>
</table>

By combining observations, interviews and questionnaires, multiple perspectives on the program become possible and cross-checking of findings adds to the validity of the data gathering and analysis. As outlined above, each method has its own strengths and
weaknesses and combining methods allow the strengths to be utilised while minimising the weaknesses (Patton, 1990).

Ethics in research

Ethics are another issue which need to be addressed for any study involving human subjects. There are several books and articles which attend to the traditional concerns of privacy, confidentiality and safety of the participants (cf. Merriam, 1989; Patton, 1990). Cognisance was also taken of a disturbing finding reported in the literature that participants in one study described the researchers as "being worse than dope pedlars" for creating a dependency on the technology which was removed at the end of the study (Bier et al, 1997). This issue was carefully considered for this particular piece of research, but due to the finite nature of the content being studied it was felt that the students would suffer no ill-effects from the fact that the material was not permanently available to them. However, this could be an issue for future research.

This study was conducted using the ethical guidelines implemented by Edith Cowan University, and efforts were made to protect the rights of the participants. The participants were all volunteers, there was no coercion to participate and no reward for participation. Closely related to the notion of voluntary participation was informed consent. Students were all required to sign a document (Appendix 15), informing them of their rights whilst participating in the study. They were informed of any potential risk or harm which could result from their participation (in this case none or negligible), told that their participation was not compulsory and alerted to the fact that they could withdraw at any time without penalty. Standards were applied in order to help protect the privacy of research participants. Students' anonymity was maintained at all times, by allowing the students to choose the names by which they would like to be identified, and confidentiality was guaranteed to the students. The ethical issue of right to service was addressed by designing the study to eliminate the use of a no-treatment control group, so that no participant would feel their rights to equal access was curtailed.

Assembly of data into useable format

Data collection involved videotaping and audiotaping students whilst they used the program, interviewing them after they had used the program, and administering pre-
post- and delayed post-tests. Once these data were collected and processed, they were analysed relative to the original research problems.

Analytic procedures fall into five modes: "organising the data; generating categories, themes and patterns; testing the emergent hypotheses against the data; searching for alternative explanations of the data and writing the report" (Marshall & Rossman, 1995: p. 113). Each of these phases involves an enormous amount of reduction of data to interpret or assign meaning to the words or actions of the participants in the study.

Software is now available to assist in data analysis. However, a word of caution has been issued by Glesne & Peshkin (1992) who state that the use of computer programs may contribute to analyses being shaped by what is convenient or compatible to the program, rather than what is appropriate to the data. In spite of these disadvantages, computer software has increased the efficiency and thoroughness of coding of data. Researchers are now able to indicate the boundaries of text segments, allowing verbatim quoting of interview responses or conversations, which can then be placed into categories and sub-categories for sorting, and as themes and patterns begin to emerge, they can be recategorised.

Using a computer program increases efficiency and may lead to greater depth and consistency in exploring issues or themes (Becker, 1984), the process of using the computer also requires the researcher to clarify thinking and carefully attend to coding decisions (Miles & Huberman, 1984).

The interviews in this study were analysed with the use of NUD•IST, as this program is capable of handling non-numerical and unstructured data by "supporting processes of indexing, searching and theorising". NUD•IST is excellent for handling a variety of data including transcripts of interviews, videos and observations. NUD•IST is essentially a database which allows the researcher to create, store and explore categories, storing information in a series of hierarchical "trees" which can be modified at any time. Results of searches are summarised in a numerical format which is compatible with most word processors, enabling results to be edited.

The videos were transcribed and verbal and non-verbal details were noted. The transcriptions were imported into an Excel spreadsheet and categories of behaviour were identified and counted. Note was also taken of navigational strategies and time on
task of the participants. The audio-tapes were transcribed and analysed to note the incidences of various forms of higher order, lower order and off-task talk.

The following table shows a summary of the research questions and the methodology used to answer them.

Table 5.5. Research question matrix adapted from LeCompte & Preissle, (1993)

<table>
<thead>
<tr>
<th>Question No</th>
<th>Rationale</th>
<th>Data</th>
<th>Data Analysis</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>How did students use Principles of Financial Investment?</strong></td>
<td>To ascertain the navigational strategies and the utilisation of the various sections. To discover the extent of investment activities and information sources applied...</td>
<td>• Interview</td>
<td>Analysis of interviews using Nu•dist software to determine the ways in which students saw themselves using the learning environment. Videos analysed to determine navigational strategies, time on task and engagement in particular areas. Transcripts of audio tapes analysed to determine the nature of student talk (Dyads only).</td>
<td>Analysis and discussion in Chapter 6</td>
</tr>
<tr>
<td>2. <strong>In what ways were the eight motivational learner effects achieved?</strong></td>
<td>To assess the importance of the eight learner effects and any relationship that may exist between them.</td>
<td>• Videos</td>
<td>Videos analysed to determine degree of time-on-task and engagement in particular screens. General descriptions of communications between learners. Analysis of interviews using NU•DIST software to determine the ways in which students saw themselves using the learning environment. Analysis of audio tapes of dyads to isolate different types of talk activity. Incidences of each type were counted to determine the extent to which the learner effects were experienced.</td>
<td>Analysis and discussion in Chapter 7</td>
</tr>
<tr>
<td>3. <strong>How did Principles of Financial Investment impact on learner activities and engagement</strong></td>
<td>To investigate ways in which critical thinking is supported by IMM and conditions necessary for it to flourish.</td>
<td>• Audio tapes</td>
<td>Descriptions of what learning appeared to be taking place. Nature of the talk. Lower order/higher order activity. Interviews analysed using NU•DIST to identify incidences of cognitive engagement.</td>
<td>Analysis and discussion in Chapter 8</td>
</tr>
</tbody>
</table>
Chapter 5

Presentation of the findings

Bogdan & Biklen (1992) highlight three common approaches in writing up research: a proposition put forward and argued; a theme or theory that emerges from the data; and a unit of a particular aspect being studied. The key fact in writing up qualitative research is an "interpretive craft and that the text can take a variety of forms, researchers can be liberated from some of the conventions that inhibited their creative expressions" (Bogdan & Biklen, 1992: p. 197). One of the problems of writing up qualitative research is the danger of overwhelming the reader with the amount of thick description necessary to impart the richness of the data, so effort must be made to present the findings succinctly, yet credibly. As stated earlier, naturalistic paradigms seek credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985). One of the techniques for achieving these is triangulation (using multiple sources and methods), and transferability of the findings rests on thick description, which has been extensively used in this study.
Summary

This chapter has described the methods used to collect and analyse the data necessary to answer the main research questions.

The research was conducted in a qualitative fashion, using a combination of action research and grounded theory. This allowed the specific problem of whether *Principles of Financial Investment* motivated and engaged the students, to be researched, and specific patterns in the data to be identified.

The research used cross-sequential sampling of the data to overcome the problems of mono-operation bias, and it was analysed using the descriptive method which allowed the researcher to describe what actually happened. The various forms of data were triangulated, interview data with observations and student talk, and this allowed multiple perspectives on the issues, as well as giving an holistic overview on the ways in which the students used the program, and increasing the validity.

The research questions as described in Table 5.6 are addressed in each of the next three chapters.
Chapter Six

Using Principles of Financial Investment

This chapter provides analysis and discussion on the ways in which Principles of Financial Investment assisted the learners to acquire and use information necessary to make share valuation and investment decisions.

This chapter presents the results of the qualitative data collection and the analyses of that data which were completed to explore:

the effect of an IMM microworld with the eight learner effects on the motivation and cognitive engagement of adult learners. To reach a conclusion, three research questions are addressed in this chapter, namely:

1. How did students use Principles of Financial Investment?
2. In what ways were the eight motivational learner effects achieved?
3. In what ways did Principles of Financial Investment impact on learner activities and engagement?

1. How did students use Principles of Financial Investment?

This question aimed to identify how students used the program Principles of Financial Investment, in a learning environment.

Data was gathered via videotapes of students working, interviews following completion of the program, and audio tapes of paired students’ conversations. Analysis of this data focussed on three emergent themes:

1. The Physical Environment: the ways in which the students physically interacted with the interface; the mental models students were able to construct of the environment and how comfortable the students felt in the virtual space.

2. Navigation/Learner Control: the ways in which the students used the program; their decision-making processes; how the gaming elements influenced their actions; and the various patterns of use across quarters.

3. Information Access: where the students spent their time; how they gained the information to make decisions; and which parts of the program were utilised.
Analysis and discussion

As described in Chapter 5, a total of twelve learners were studied, eight of whom worked in pairs, and the other four worked alone. Data collected from both the pilot study and the main study was used in the analysis. The videos of the students using the program were transcribed and coded using NU•DIST (Qualitative Solutions and Research, 1993). NU•DIST is a computer program designed to aid researchers in handling qualitative data by supporting processes of indexing, searching and theorising. Each answer given in response to the interview questions was coded according to pre-determined categories (hereinafter called nodes), and where the answer demanded, sub-categories were created.

The responses in these nodes were then grouped to identify themes and to link ideas and construct theories about the data. These themes were then drawn together to create a thick description (Patton, 1990) of what occurred and to draw some conclusions.

Ten categories of learning activity were identified. These corresponded to the eight areas of the microworld (tutorials, viewing room, office, buy/sell screen, library, broker, reception, stock exchange) plus browsing and hints. The time which each student or student pair spent in each area of the program was put into a spreadsheet. This enabled the comparison of activity between students to be tabularised and charted. The initial comparison was of the approaches adopted by the students and time spent by the paired groups and the single students.

An overarching aim was that the program should be designed to work effectively both for students collaborating and for students working in isolation, and it was therefore important to identify areas of the program which did not support such a precept and to discover ways to overcome any perceived weaknesses.

Chapter 3 described the development of the program which incorporated the eight learner effects of immersion, reflection, learner control, flow/play, collaboration, curiosity, fantasy and challenge.

This chapter will begin with a cross-case analysis (Patton, 1990), grouping together data from all the students to describe variations in usage and synthesising the data to "identify and extrapolate lessons learned" (Patton, 1990, p. 425). The chapter will then move to case-study analysis, looking at what students did, for how long, and in what way.
Description of Students

Twelve students in total took part in the in-depth study—4 female and 8 males. The demographic information on each of the students is as follows:

Karen was an Australian full-time student in her early twenties. She was articulate and demonstrated a high degree of enthusiasm for the program.

Bill was an older student, in his mid-40s with considerable business experience. He was English and was paired with Karen. They formed an industrious and conscientious team.

Mick was South East Asian and a full-time student in his mid twenties. He demonstrated considerable trepidation towards the program as he had no business background and no prior knowledge of financial theory.

Sharni was a Sri-Lankan in her early twenties. She was a full-time student with no business background, but was very anxious to acquire a good understanding of financial theory.

Jean was in her late teens and a full-time student. Of Australian extraction, she had little prior practical knowledge of business or finance and confessed that she perceived financial theory to be very boring.

Greg was a part-time student in his mid thirties with little background in business.

Mark was a full-time student in his late twenties. He was an Australian with about half his business degree completed.

Simon was in his mid twenties and an Australian. He was enrolled part-time in the business degree and had failed the finance unit once.

Marie was South East Asian and in her early twenties. She was a full-time student in business.

Jon was Polish and in his mid twenties. He was very interested in financial theory but had little prior knowledge.

Mark T was South East Asian in his early twenties. Although he had not completed financial theory formally he claimed that all Asian people are interested in finance.

Ted was an Australian student in his late teens. He asserted that he was not interested in finance and did not like the subject although he was enrolled.
The Physical Environment

The ways in which the students used the physical environment, the interface and the mental models they formed of the environment were an important point of enquiry of the research. Analysis of the interviews and the videotapes showed that most of the students were fairly comfortable in the learning space, but that problems did appear from time to time, particularly disorientation. However, this was not an insurmountable problem and the students who experienced it felt, for the most part, that they learned from the occurrence.

Dissonance can be a valuable tool—the act of getting lost helped teach the students the relationships between components. Several of the students reported feeling lost, but none felt that this was a great problem:

I was a bit lost, but I found the start and then followed through (Mick interview)

At first I felt lost because I didn’t know which approach to take. Obviously you have to investigate the company before you invest, so it was a question of after that what do I do. But it’s ok, I found my way through (Marie interview).

Because we had the little map it didn’t feel worrying or anything. We had a few problems at first because we weren’t sure exactly what to do, but just going into rooms to have a look, because you could always come out of them again, it’s not like you go in them, you’ve got to do something, you can explore a bit (Karen interview).

The students were also given a booklet which described the contents of each screen and gave navigational “clues”. It became apparent that few of the students used this book selecting instead to use an exploratory, intuitive approach to moving around the environment. This approach was summed up by several of the students:

I just had a look around. I felt comfortable, it was easy to use, I could do it without looking at the instruction book (Jon interview)

We were trying to find our way around a bit, but we worked out how to find our way round pretty quickly. It’s just a matter of exploring and working out which place is best to go to first (Greg interview).

That was pretty easy because you had that little map [the blueprint on the wall] and you always knew where to go (Karen interview).

It was a bit hard at the beginning. I didn’t understand, but after a while in the next quarter I began to understand how to do it. It then became very simple to move on (Mark T interview)
The three students who completed the pilot study and who had not covered any of the theory previously had the most problems with orientation, but discovered that by exploring the environment thoroughly they eventually identified all the navigable elements and by the end of the program were comfortable in the environment. Their initial apprehension and disorientation was attributed by them to a lack of knowledge and understanding of how an investment environment operated, rather than an inability to navigate around the program.

The Interface

Most of the students found the interface to be intuitive and were able to relate it to a real-life scenario. For example, Jean and Greg, like several of the other students, did not hesitate when confronted with the initial screen. They had some discussion as to who would use the mouse and then talked about how to tackle the program. When unsure of what to do they were happy to explore, clicking on objects to see what, if anything, happened. They very quickly worked out that the map on the wall allowed them to go to different areas within the program and discussed where to go first for best effect:

Institute of Sound Investment. Shall we hit it before we start spending our money? (Jean & Greg video)

This initial uncertainty with the navigation was quickly overcome and they commented that they felt like they were in a realistic environment:

When I was in the Broker's room I felt like I was looking at a wall in the stock exchange and that type of thing, and the library. Not so much the people, but the props, the portfolio share advice that you got, the sheets on each company, to me that was very realistic, yes (Jean & Greg interview).

Several other students found the interface helpful in situating them in the activity and overcoming the problem of inert knowledge by helping them to transfer their knowledge to real-life problem solving tasks. The intuitive style of the interface was considered to be instrumental in this. Simon's comment in his interview sums up the feelings of several of the students when he stated:

The whole thing was really well put together because you've got all the important bits like GDP and then the interest rates and inflation, plus all the share listings plus you had background
information, that’s the first thing you do when you buy and sell shares is look at past events which was all there (Simon interview).

Not only did some of the student comments reflect on the content, but several also alluded to the graphical nature of the interface which enabled them to visualise where they were and what was going to happen. The comments of several students specifically referred to the logical quality of the interface which they felt helped them find their way around, as evidenced by the comments below:

Just going into rooms to have a look, because you could always come out of them again, it’s not like you go in them, you’ve got to do something, you can explore a bit. The graphics are very good—you go through a door—very logical. You go into the gallery and the stock exchange, that’s very logical so you had a graphical fix rather than just trying to click on some disembodied button or something, at least you imagined yourself in the stock exchange or imagined yourself in the Broker’s office (Karen interview).

I liked the fact that we could change our minds and go straight to another place, interrupting the to or the other props. I didn’t have to sit and wait for the voice to finish talking I could just move on (Greg interview).

I found that we always knew where we were, the map on the wall showed us where we’d been and where we hadn’t been. I’ve used a couple of these before which have been very mechanistic, this kind of made us feel part of it (Bill interview).

An important part of the interface was what some of the students termed “props”. These were the tv, telephone, filing cabinet—all the unexpected and surprise elements of the environment:

The little props helped it to be fun, the phone, tv, the fact that you get to check your share prices and portfolio, that’s all good fun (Jean interview).

Making profits from shares makes it more relevant, the sound effects are not bad at all and the tv, the newsreader is very good, and the phone that gives you advice, the colour is good (Marie interview).

The evidence from the interviews is that, for the most part, the students found that the learning environment was easy to use, intuitive, fun, and that it helped them form a mental model of where they were, where they had been, and where they had yet to go.

Most of the students found that they were interested enough to want to use the learning environment and found that they could move round it in a realistic fashion.
Apart from when the computers crashed, or there was a glitch in the program, most of the students seemed to be totally unaware of the computer system itself, the interface and the information being almost inseparable from each other. This is borne out by some of the students’ comments, of which the following is an example:

I can’t see how in real life it would be a great deal different, you’re given information and you buy and sell, no-one was pointing the finger saying that you haven’t used the knowledge you’ve gained or it was left to you, so I thought it was a reasonable assessment of what it would be like if you were going out and doing it in the workplace (Jon interview).

Most of the students found that the environment provided the opportunity to learn through the interaction of the instructional resources, the activities and themselves.

The three students who completed the pilot phase of the study found that the save structure was rather clumsy. This was then modified so that saving could be carried out with keystrokes rather than mouse clicks.

The interface was the only means by which the students could connect with, and control the operations of the program, and because of this, the way the students interacted with the interface was of prime importance. Generally, they found the way the program operated to be logical and intuitive, transparent until the computer interrupted them by hanging or crashing, and one student reported they he and his partner did not experience any frustration with the granularity—finding that they could interrupt the program at any point and move on. Several of the students also reported that the interface helped them relate to the content, making it meaningful and real, which in turn helped them to perform the required tasks. Although simple and stylised, the graphics did not appear to disconcert the students, instead they reported that they helped them create mental models of the program.

This feedback from students highlights the importance of providing an interface that the students find meaningful and realistic, and that creates a sense of two-way communication with them. The majority of the students appeared to be directly involved in the process and their attention was devoted, almost exclusively, to the task and not to the tools. This is described by Thomas & McCredie (1994) as an example of direct engagement where the task, tool and person are melded into one.

Without exception, all the students found the auditory and visual enhancements of the interface helpful in both carrying out the required tasks and understanding how the program was designed. Some took slightly longer than others to come to terms
with the physical environment, but by the end of the program felt comfortable within it.

*Principles of Financial Investment* appeared to be successful in eliminating the decontextualised and abstract feeling of poorly designed multimedia. This was achieved through the eradication of low level, point and click interactions, substituting instead a rich, organic environment to which the students could relate as something from their own lives. Although the sample group was small, it was representative of both genders and a good cross-section of ages and cultural backgrounds. None of the students reported antithetical feelings towards the physical environment, instead finding it logical and non-mechanistic.

**Navigation/Learner Control**

Navigational patterns were identified from the video tapes of students using the program and flowcharts of usage were constructed. However, in some cases these were so complex that they became unreadable and a narrative description was chosen to provide a simpler, but richer, picture of the navigational strategies. The following illustrative case studies (Patton, 1990) show the individual approaches used by the students.

**Bill and Karen**

Bill and Karen went into the program and after a short discussion, went straight to the Institute and enrolled in tutorial 1. They spent 36 minutes in tutorial 1, scrolling through, checking each other's understanding of the formulae and working out the answers. They spent some of this time debating and arguing about how the formulae should look, writing down their answers, coaching and testing each other. After completing all of tutorial 1 they discussed what to do next and decided to enrol in tutorial 2, where they spent another 30 minutes behaving as they did in tutorial one, coaching, testing, discussing, arguing, reading aloud and solving problems. They showed elation when they solved the formulaic problems. They finished tutorial 2 and checked the objectives for tutorial 3 but decided not to enrol, instead they went to the library and began investigating the company reports of the six stocks, sometimes discussing current world events in relation to what they were reading. They then visited the stock exchange and went to the viewing room to look at the current prices and then went back to the library to consolidate the information on
each of the stock in light of prevailing prices. A visit to the Broker was next, where they read the quarterly reports and decided to break their portfolio into three. They spent several minutes planning what they were going to do and making decisions as to what to buy, and then went to the buy/sell screen. They moved to the office, where they answered the phone and watched the news on the television. They warped to the next quarter, went to the stock exchange, viewing room, reviewed comments of Sean and Wanda, back to the Broker, bought more shares and went back to the office. Karen and Bill then warped, listened to the phone and watched the television, discussed what they had seen and heard, reviewed their portfolio where they discussed the prices, values and implications of Frank's illness. They then went to the stock exchange, viewing room to see what Sean and Wanda were doing, back to the Broker to review the quarterly information, bought and sold after discussion (and some minor arguments) of the implications of various information they had read or heard, and then went back to the office where they warped, answered phone and watched television. This sequence of stock exchange, broker, buy/sell, office, warp was repeated twice more. They then checked their portfolio and discovered that they had reached the end of the program. They finished with a total profit of $39,345.

Discussion

After quarter 0, Karen and Bill developed a routine within the program of moving from the office, to the stock exchange, to the Broker and back to the office. They spent almost no time browsing, choosing rather to talk to each other about where to go and reading the handout to review the possibilities. They quickly identified that Tutorial 3 did not contribute greatly to their ability to value shares and spent less than 30 seconds reviewing the objectives of the course before moving on to other parts of the program.

Karen and Bill spent the longest period of time in the tutorials, and the least amount of time in the Broker's office and made the largest profit of either group. They spent a substantial amount of time building their knowledge about share valuation and investment and were able to make inferences about what was going to happen to the particular stocks, obviously gaining knowledge from their discussions with each other. Due to the fact that they had the opportunity to put their knowledge to the
test in an authentic way, much of their time was spent in higher order tasks of problem-solving, decision making and synthesising the information.

**Jean and Greg**

Jean and Greg spent some time discussing where to go after they had enrolled in the program and decided to try the "What do you know?" section. They then explored the office, listened to the telephone and watched the television before deciding to visit the Institute again and enrol in tutorial 1. They spent 29 minutes in tutorial 1, and then went to the stock exchange, visited the viewing room and read the information from Sean and Wanda. They then went to the library and read the company reports, discussing the information before visiting the stock exchange and Broker. They then decided to go back to the Institute and enrol in tutorial 2, spending 19 minutes working through the information.

Having completed tutorial 2 they visited the Broker and looked at the quarterly reports, spending time valuing the shares and discussing the price implications. They went to the buy/sell screen but decided not to buy, instead returning to the Institute and enrolling in tutorial 3 where they spent 11 minutes.

After tutorial 3 they went back to the Broker and the buy/sell screen and proceeded to have a long discussion about each of the stocks and deciding on their investment mix. After investing they went to the office and warped, watched the video, answered the phone and examined their portfolio. They then went back to the Broker and looked again at the quarterly reports before returning to the buy/sell screen and buying more shares. They moved to the office, warped, answered the phone, watched television and reviewed their portfolio, discussing the price movements. Then back to the Broker and buy/sell screen, making more investment decisions, but occasionally moving back into the Broker's reception to check information in the reports. They then went to the office, warped, watched television, listened to the telephone and inspected their portfolio.

They repeated the sequence of broker, buy/sell screen, office for the final three quarters and then stopped having made $35,239 over the time period.

**Discussion**

Like Karen and Bill, Jean and Greg developed a pattern of working within the program, but it took much longer for them to achieve this. They spent some of their
initial time in the program in the "What do you know" section of the program, before proceeding to tutorial 1. They spent time between each tutorial reviewing some of the other material contained within the program, but did not invest until they had done all of tutorials 1 and 2, and part of tutorial 3. Apart from the time immediately after completing tutorial 1, Jean and Greg did not spend time in any section of the program other than the tutorials, the Broker's office, the buy/sell screen and their office. They did not review any other information. Interview responses highlighted the fact that, having completed most of the tutorial material, they felt they had sufficient theoretical background, and only needed the market information necessary for making their investment decisions.

Jean and Greg discussed the information in the tutorials at length, sometimes arguing, sometimes coaching each other. They spent equal amounts of time reading aloud and reading to themselves and it appeared that they acquired the information they needed from reading, from discussing and from arguing over some of the contentious points. Like some of the other dyads, Jean and Greg appeared to gain the most from the tutorials, but they also utilised the Broker fairly extensively, particularly towards the end of the program. Their decision making revolved around spending quite long periods of time discussing their portfolio and the price movements and making plans for their investment strategy.

Jean and Greg took an heuristic approach to the use of the program, discovering the information and furthering their investigation in order to make sound investment decisions.

**Mark and Simon**

Mark and Simon went straight to the Institute after registering and enrolled in tutorial 1, where they spent a total of 13 minutes. Having quickly worked through the formulae and worked through the examples, they decided to enrol in tutorial 2, where they spent 8 minutes. They went to the stock exchange where they decided to move to the library and review the company reports. They then went back to the stock exchange, listened to the hints, went to the viewing room and looked at Sean and Wanda, wrote down the current stock prices and discussed the implications. They went to the Broker's office and reviewed the quarterly reports. Having looked at most of the reports they accessed the hints again, and then went to the buy/sell screen, but didn't invest. They then visited the office, answered the phone and
explored various items—the portfolio, video, and filing cabinet. They went straight to the library and looked at the historical information on each of the stocks. They moved to the Broker's office and went to the buy/sell screen and had a long discussion on what to buy and how much. They moved between the quarterly reports in the Broker's office and the buy/sell screen while they made their decisions. Having purchased their stocks, they went to the office, listened to the news and telephone and warped. They listened to the stock market report, answered the phone and discussed the implications of the message. They went to the Broker's office, buy/sell screen and bought more shares. Then went to the office, warped, checked their portfolio, then went back to the viewing room in the stock exchange, where they accessed Sean. They then read through the market indicators and the economic information in the Broker's office and Mark explained to Simon what happened to the shares and why. They saved their data.

The system crashed, but they were able to recover their data.

They bought some more shares, went to the office and viewed their portfolio, warped, looked at the portfolio again and discussed their gains. They went back to the Broker where they looked at the pamphlet called "Investing by Stars", they also looked at the quarterly reports and economic update, discussing the market indicators. They bought and sold some shares and then went to the office and warped. They reviewed their portfolio, discussing their gains and losses, then listened to the phone and talked about what they heard. They decided to visit Sean and Wanda in the viewing room to see what they had to say about events.

They went back to the Broker and reviewed the quarterly reports and the stock movements, analysing their current holdings. They went to the buy/sell screen and made decisions based on current events, went to the office and warped. They listened to the news and cursed, looked at their portfolio and discussed rises and falls and made buy and sell decisions.

Simon and Mark then went back to the viewing room and read Sean and Wanda's comments, before going back to the office and looking at the portfolio, discussing what it all meant. They went to the buy/sell screen and invested, went back to the office and reviewed their portfolio. They reached the end of the program having made $23,500.
Mark and Simon had slightly different orientations to learning—Mark tending to be a divergent thinker, using inventive problem solving techniques and wanting to take an exploratory approach to the program, and Simon being a convergent thinker, wanting logically correct answers. However, their collaborative approach was such that they could overcome these difficulties, talking through their inclinations and coming to a consensus on the approach they should take at any given time. This approach varied depending on what they were doing, Simon dominating when they were planning their strategies and solving formulae, and Mark deciding when and where they should go at any time.

**Discussion**

Simon and Mark immediately enrolled in tutorials 1 and 2, but didn’t investigate tutorial 3 or the “What do you know section”. Analysis of their conversation highlights the fact that they wanted to “push on and start investing”. They spent the least time of any of the dyads in the tutorials and didn’t appear to place much value on the information in the tutorials, preferring instead to gain their theoretical knowledge from other parts of the program, finding this to be more relevant to their needs and the needs of the tasks they had to perform.

Having read and worked through the formulae in the first two tutorials they explored the stock exchange and accessed the hints and reviewed the information given by the on-line characters. They then moved between the Broker, the buy/sell screen and the office for three quarters, then broke the pattern by going back to the stock exchange and looking at the on-line characters. They did this for the final three quarters, changing their initial pattern completely. Instead of relying less on the modeling provided by the on-line characters, they began to depend on it more to help them make their investment decisions. In spite of this, they did have several in-depth discussions regarding their investment strategies and also had several reflective conversations where they considered what was happening and why. They appeared to be completely absorbed into the physical environment and were seen to become quite animated during their use of the program.

Mark and Simon spent some time planning, goal setting and working out what was meaningful. They were behaviourally active, taking action to solve the problems that were inherent in the program, and again their engagement was assisted by the fact
that they were constructing their own knowledge from the information provided within the program.

Analysis of their talk highlighted the fact that Mark and Simon were very goal oriented, moving from an emphasis on knowledge acquisition to the application of that knowledge. The relevance of the setting and the material appeared to help them achieve this.

**Mick and Sharni**

Mick and Sharni were the pair who completed the pilot phase of the study. They were also the only pair who were in first year at University.

Once they registered in the program, Mick and Sharni went straight to the Institute and enrolled in tutorial 1, spending 15 minutes completely absorbed in the information. As soon as they had completed tutorial 1 they enrolled in tutorial 2 and spent a further 20 minutes discussing the content and working through the formulae. When they had finished tutorial 2 they discussed where to go next and decided to try buying some shares so went to the buy/sell screen. Having talked about what to buy they decided to get some background information on the stocks and went to the economic forecasts. Mick then wants to explore, and went to the stock exchange where they viewed the prices in the viewing room. They then moved between the library and the viewing room while they checked prices against the company reports. This took several minutes. They then went to the buy/sell screen and purchased some shares. Mick and Sharni are then unsure what to do next, they haven’t explored enough to discover the warping and they haven’t read the booklet on the program. They spent a minute browsing through the program and came to the office, where they answered the phone. They then watched the video and then went to the portfolio and tried to work out how to warp. They decided to go back to the viewing room to see if the prices have changed and discover Sean and Wanda and read their comments. In the absence of discovering the warp, they returned to the buy/sell screen and bought more stocks, and then went back to the economic updates, checked the information and bought still more shares. They kept returning to the office, intuitively understanding that the warping happens there but failing to find the clock. They went back to the Broker and bought more shares, then to the office and worked out how to warp. They listened to the television and answered the phone and obviously enjoyed the message. They checked their portfolio and were
pleased with their gains. They went back to the Broker and this time decided to sell some shares, before going back to the office where they warped and discussed how they knew how well they'd really done and noticed the notional values. They checked the Broker's reports once more, made more buy and sell decisions and went to the office and warped. Mick and Sharni finished with $22,080 profit.

Discussion

Mick and Sharni enrolled in the first two tutorials, but didn't look at tutorial 3 or the "What do you know" section, like Mark and Simon they wanted to take a more practical approach to their learning. They were the only dyad who had problems navigating through the program in that they couldn't intuitively understand how to move between quarters. They did not look at the printed instructions and did not ask for help, instead preferring to browse extensively until they found the clock in the office. Once they found the clock then their routine became smooth but unvaried, moving between the Broker, the buy/sell screen and the office for each subsequent quarter.

An analysis of the time Mick and Sharni spent in the program shows that they divided their time fairly equally between all the information sites, with the exception of Tutorial 3 and "What do you know". It is very difficult, from the analysis of the videos, to pinpoint exactly where Mick and Sharni gained most of their theoretical knowledge, but it is obvious that they gained a lot from talking to each other, discussing the formulae, coaching and assisting each other to understand the information. Mick and Sharni also spent time in silent reading, only reading aloud to each other information they deemed to be significant.

Mick and Sharni used the Broker extensively as an aid in their decision making process, discussing the information they found in the reports in the office, and constantly checking this information before making their investment decisions. It appears that they didn't like the isolated facts that were available in the tutorials, instead needing the information to be timely and relevant, and taking direct action to solve the problems rather than using the theory to interpret them.

Marie

Marie worked alone on the program and began by going to the "What do you know" section before enrolling in tutorial 1 where she spent five minutes. She worked
through the questions silently, running her finger down the screen and then went to the Broker and checked the quarterly reports. She spent time in silent reading and went to the information on discount rates.

Having looked at the material in the Broker's office, Marie went to the stock exchange and listened to the hints. She went to the viewing room and examined the prices, and looked at Sean’s and Wanda’s comments, then she returned to the Broker and looked at the market indicators. She visited the buy/sell screen but didn’t buy. She then reviewed the quarterly reports and read the recommendations and revisited the buy/sell screen but still didn’t buy. She went back to the bulletins in the Broker’s office and scrolled through, then back to the buy/sell screen and obviously thought about buying. She wrote down the current prices, spending time thinking about what to buy and how many. However, she still didn’t buy any shares. She revisited the viewing room, the library, the company reports and followed the text with the cursor. She also pointed at the screen. She went to the office and listened to the phone message and then went back to the stock exchange, picking up a hint and reviewed Sean and Wanda, to the Broker picking up a hint and then to the buy/sell screen. She finally started buying. She saved the data and then moved to the office and viewed the video and then checked her portfolio and found that she’d made a good profit. She warped, checked her portfolio again, watched the news and listened to the telephone message. She then returned to the Broker and read the quarterly reports before going to the buy/sell area where she made some more purchases. She saved her data, went to the office, looked at her portfolio (and noticed that this time she’d lost quite a lot of money), warped, listened to the phone message and watched the television. She checked her portfolio for price movements and then reviewed the quarterly reports in the Broker’s office. She sold some shares in the buy/sell screen. The system crashed and she retrieved her data and went through the buy/sell, office, warp, phone, video, portfolio cycle again as she had lost her last set of transactions by not saving. She saved her data and went to the quarterly reports, bought and sold some more shares, went to the office and warped, looked at the quarterly reports, bought and sold, went to the viewing room to review Sean and Wanda’s activities, went to the office, warped, checked her portfolio (and noticed she’d lost more money on two of the stocks), saved, went to the quarterly reports and then the buy/sell screen, the office, warped and checked her portfolio.
Marie finished with a balance of $126,000—a profit of $26,000. Although Marie appears to have made a healthy profit, she made one very good investment decision, followed by several disastrous ones, possibly due to her lack of theoretical knowledge.

Discussion

Marie's navigation seemed to be driven, at least for some of the time, by her lack of confidence in what she was doing. She visited the buy/sell screen three times without buying, and also accessed the hints and tips several times. Marie appeared to have used the program very cautiously, but also demonstrated reflective thinking by writing down her formulaic calculations, actively searching for information and running her finger down the screen as she made her decisions. Her decision making after the computer crashed appeared to be more decisive and she navigated through the learning environment with more confidence and much more quickly. A pattern of use began to emerge, where she primarily moved between the office and the Broker, occasionally moving to the viewing room to check prices and the actions of the on-line characters.

Marie used the information in the Broker's office as her primary source of information, possibly because it was more practically oriented and relevant to the problem solving tasks. Her interest in the information remained high, moving between screens to maintain her visual momentum (Woods, 1984) and enabling her to extract and integrate the information necessary for decision-making.

Jon

Jon was the most thorough of any of the single students. He spent the longest amount of time in the program and spent a lot of time in each of the content areas.

He, unlike most of the pairs, did not go straight to the Institute, but went to the Broker's office where he read the economic information, examined the graphs and scrolled up and down. He then looked at the market indicators and the discount rates. He read the quarterly reports for four of the stocks and then went to the buy/sell area, looked, but didn't buy anything. He then explored the office, went back to the reception, out to the street, and then back to reception and decided to go to the Institute. He enrolled in tutorial 1 and scrolled through, reading and writing. He spent 9 minutes in tutorial 1, working through the examples (with which he
seemed to have little trouble) and then enrolled in tutorial 2, which he worked through the examples thoroughly. He spent a further 11 minutes in tutorial 2, and then enrolled in tutorial 3, where he spent 4 minutes. He then, very quickly, worked his way through the “what do you know” section and then went back to the reception area. He moved his cursor round the map on the wall obviously working out where to go and chose the stock exchange, and the hints. He went to the library and read the company reports and the economic data and stockmarket report. He then went back to the stock exchange, listened to a hint and went to the viewing room and read Sean’s and Wanda’s comments. He went to the office and began randomly clicking on objects to see what they’d do. He went back to the Broker, checked the quarterly reports and then went to the buy/sell screen where he overspent his money. He reinvested, then went to the office, checked his portfolio and watched the television. He went to Reception and then the viewing room and then back to the office, warped, listened to the phone, checked his portfolio, went to the stock exchange viewing room, checked Sean and Wanda’s comments, went to the buy/sell area, bought more shares, went to the office, warped, listened to the phone, checked his portfolio, checked the viewing room prices and Sean and Wanda, went to the buy/sell area, went to the office, warped, checked the phone and his portfolio. Jon made $28,890 of profit.

Discussion

Jon’s approach to the program was very different from any of the other students. He spent some time in the Broker's office, examining the reports, before browsing through the rest of the program. He then went to the Institute and enrolling in each of the three tutorials and the “What do you know” section. He worked through these quickly, before going to the Stock Exchange and using the hints and on-line characters for information. He also reviewed all the information in the library. He then explored a little longer before making his initial investments. Having made these investments he then quickly settled into a pattern of use which involved the office, the viewing room, the on-line characters, the Broker, buy/sell screen and then back to the office. Jon used the game’s facilities to help him with his decision-making, but also used the theoretical information he had gained from the tutorials to supplement this.
Mark T

Mark T registered and immediately went to the hints. He then browsed round the viewing room, the institute, the Broker and back to the viewing room where he read Sean’s and Wanda’s comments. He went back to the Broker and read the quarterly reports and then went to the buy/sell screen where he wrote down the current prices. He went back to the Broker’s reports and commented aloud that he should be buying more than the Broker’s report suggests. He then checked the market indicators and the economic information. He went to the office where he spent a few seconds in structured browsing, listened to the telephone message, looked at his portfolio, watched television and obviously thought about where to go next. He read the information booklet and decided to warp. He laughed at the warping noise and then listened to the television news and went to his portfolio, running his finger down the screen as he checked the figures. He then listened to the phone and exited the office, going to the library and browsing through the company reports. He then went to the Broker and the buy/sell screen but doesn’t buy, instead going back to the quarterly reports in the Broker’s office. He can be heard talking to himself as he reviews the formulae, running his finger down the screen. He went back to the buy/sell screen and started buying, talking aloud about interest rates and pointing at the screen. He used his calculator extensively, spending time to work out values.

He moved back to the office, checked the phone, warped, checked the phone again and then went to his portfolio where he checked the price movements for the quarter. He went to the buy/sell screen, then went to the quarterly reports in the Broker’s office, went back to the buy/sell screen and made more investments. He saved his data and then went back to the office and warped. He listened to the telephone and muttered “heart strain” several times. He went to the Institute but didn’t linger, instead going back to the quarterly reports and then back to the buy/sell screen, invested and then saved his data. He went to the office and warped, checked the telephone, television and his portfolio. He then moved to the Broker’s office, checked the reports in the office, went to the buy/sell screen, invested and saved. He returned to his office, checked the portfolio, warped, checked the portfolio and then went back to the reports in the Broker’s office, invested at the buy/sell screen, went to the office, warped and checked his portfolio. He then exited to the street and saved his data. Mark T finished the program $13,540 in profit.
Discussion

Mark T spent his initial time in the program browsing around the learning environment, orienting himself and seeing what was available. He was almost the only student who referred to the information booklet in any depth and began to develop a pattern from thereon. He was also the only student who warped without making an investment. After this, he developed a fairly definite pattern, of Broker’s reports, buy/sell screen, office, warp, deviating only slightly to visit the Institute (briefly). This pattern was repeated for every quarter.

Mark T appeared to use the information in the Broker’s office extensively as an aid to learning the theory and also for decision-making as he divided much of his time between the Broker’s office and the buy/sell screen, checking carefully current information before investing. Analysis of Mark T’s interview highlights the fact that he learned from the process of exploring the environment, identifying the elements necessary to help him with his decision making and problem solving. His interview comments confirm the fact that he found the Broker’s office most useful in providing him with theoretical information and he enjoyed the challenge of sorting the relevant information from the irrelevant. His approach to the program was self-directed, inductive and exploratory.

Although Mark T spent some time in unstructured browsing, he also actively searched for information, particularly after he had used the information booklet. He was also the only single student to verbalise some of his thoughts as he moved through the program, allowing an insight into his reflective thinking and decision-making processes.

Ted

Ted spent his first few minutes in the program browsing through the various elements obviously seeing what they did and how they fitted into the program as a whole. When he visited the Broker’s office he skimmed through each of the quarterly reports, again not really engaged, but just browsing. He went to the office and explored each of the media elements, visited the Institute but didn’t enrol in any tutorials, went to the stock exchange and the viewing room, looked at Sean and Wanda, then went to the library and skimmed through the company reports. Having visited every area of the program, he decided to return to the Broker’s office, listened to the hints and then read each of the information sheets on the bookshelf—the
quarterly reports, the economic update and the market indicators. He went to the buy/sell screen and spent several minutes buying shares, sometimes moving between the buy/sell screen and the information in the Broker’s office. He went back to his office and clicked the warp button, but cancelled it, obviously unsure whether it was the correct thing to do. He looked at his portfolio, and, satisfied, warped. He then accessed each of the media elements, the phone, the video and his portfolio.

He then went back to the Broker’s office and read the quarterly reports much more carefully, working out the formulae, writing information down and running his finger down the screen. He appeared to be totally engaged in this activity. He went to the buy/sell screen and reflected for a couple of minutes, tapping his fingers, before returning to the quarterly reports, checking graphs. He moved between the buy/sell screen and the quarterly reports for each stock, sometimes buying and sometimes selling.

He then went to the Institute and enrolled in tutorial 1 and spent 7 minutes carefully reading through the information. He did not complete any of the examples. Having read through to the end, occasionally moving back through the material, he went to the office and warped and checked his progress in the portfolio. He watched the video and listened to the phone message, contemplating what was said, muttering to himself and tapping his fingers. He moved to the viewing room, but seeing nothing new, went back to the quarterly reports in the Broker’s office. He went to the buy/sell screen and made several buy/sell decisions, moving constantly between the quarterly reports and the buy/sell screen. He thought about his decisions, writing information down and calculating amounts.

He then went to the Institute and enrolled in tutorial 2, and spent 6 minutes reading the information, but not working through the examples. Having completed the tutorial he made one more buy/sell decision and then went to the office, checked his portfolio, warped and rechecked his portfolio. He then checked the other media elements in the office, before returning to the Broker and moving between the buy/sell screen and the reports in the Broker’s office.

He then went to the Institute and enrolled in tutorial 3 spending another 6 minutes reading the material. He went from here to his office, checking his portfolio carefully, pointing at the screen and looking closely, and then went back to the Broker’s office and the buy/sell screen. He spent a short time browsing between the
viewing room, the library and the Broker and then read Sean’s and Wanda’s comments. He accessed the hints in the stock exchange, went to the office and warped and again checked each of the media elements. He completed the program and made a profit of $17,250.

Discussion

Interestingly, Ted did not warp immediately after making his buy/sell decisions, but instead went to the Institute each time and enrolled in a tutorial. This contrasts with every other student and when asked why he navigated through the program in this way, he replied that he didn’t know, he just thought it would be useful to follow his practical investing with the theory.

Ted also moved constantly between the reports in the Broker’s office and the buy/sell screen, checking the economic forecasts and indicators prior to investing in each share. This behaviour replicates that of some of the other lone students and like them, Ted claimed that he would rather review material relevant to the current market and the shares than spend a long time completing tutorials which were based more on hypothetical situations.

Ted spent nearly 80% of his time between the tutorials, the office, the Broker and the buy/sell screen and used these areas to gain his theoretical knowledge and also as a foundation for his investment decisions. His use of the tutorials mirrored the intention of the program developers, where it was hoped that the students would complete the tutorials gradually, on a need to know basis. In fact, Ted was the only student who did use them in this way, and as a result they were rewritten in an attempt to encourage wider use.

Summary

Most of the students coped well with the uncertainties and complexities of the program. Their domain knowledge and strategic knowledge became interwoven and as this occurred, their problem solving and decision making became quicker, and their cognitive engagement became more pronounced. The repetitive process represented by the six quarters helped the students to acquire and implement cognitive strategies. Although several of the students spent a fairly large percentage of their time working through the tutorials, none of the students appeared to be particularly interested in the straight acquisition of theory, rather they were more
interested in the practical application of their knowledge. This has ramifications for future IMM developments, where straight theoretical components may need to be de-emphasised and more opportunities for application of their knowledge be included.

As evidenced by the videotapes, all the students experienced high levels of engagement with the program. This was assisted by the students constructing their own knowledge from, and patterns of using, the program. Those students who planned their investment strategies were beginning to think about the long-term effects of what they were doing, rather than trying to maximise their earnings in the short term.

All the students managed to grasp the context of the program, and, with minor exceptions, had a clear conception of the relationships across the information displays in the program. Generally, the students found the system to be transparent, focussing instead on the iconic representation presented by the interface. This iconic representation appeared to assist them in problem solving and chunking of complex information into a smaller number of higher order units (Woods, 1984) allowing them to follow their own route through the program.

There were substantial differences in the ways in which the students used the program. A few of the students totally focussed on small subsets of the information to the exclusion of others, whilst other students used a broad cross-section of the program to gain their information. This highlights the importance of having a variety of representations of the information available to accommodate the individual needs of students.

The means by which students made decisions was of great interest. The collaborators were able to talk through their decisions, sometimes arguing, sometimes debating various points.

The singles however, because they didn’t have partners tended to use elements of the program to assist them in making decisions, such as the information contained in the Broker’s office, and Sean and Wanda.

These differences in the decision making processes were highlighted by the final financial outcomes of the groups, as evidenced in Table 6.1.
Table 6.1 Final profit made by each dyad or single student

<table>
<thead>
<tr>
<th></th>
<th>Final Profit ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen &amp; Bill</td>
<td>39,345</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>35,239</td>
</tr>
<tr>
<td>Mark &amp; Simon</td>
<td>23,500</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>22,080</td>
</tr>
<tr>
<td>Marie</td>
<td>26,000</td>
</tr>
<tr>
<td>Jon</td>
<td>28,890</td>
</tr>
<tr>
<td>Mark T</td>
<td>13,540</td>
</tr>
<tr>
<td>Ted</td>
<td>17,250</td>
</tr>
</tbody>
</table>

The average profit of the dyads was a little over $30,000, whereas the singles' average was $21,420. This is a substantial difference that can perhaps be explained by the positive effects of students collaborating with each other, planning and talking through strategies and reflecting on performance as they moved through the program, adjusting their strategies as events unfolded.

It is clear that if achievement is measured by maximisation of financial resources, then the dyads were more successful. Again this could be due to the nature of their communication—the fact that they used their time more efficiently and were able to apply the information more appropriately. But it must be noted the two of the independent learners made a higher profit that two of the groups suggesting that for some learners there are other advantages which can be gained from independence and perhaps limitations in learning in collaborative settings.

The students were encouraged to be reflective, by the active process of exploration and discovery (Boud, Keogh, & Walker, 1985), and by applying their newfound skills and knowledge in new contexts. That they were reflective was evidenced by the way in which they read through the material, either aloud or to themselves, running their fingers down the screen, discussing it with a partner, bringing current world events to bear on what they were reading, trying to analyse and "second-guess" the information and applying it to their share valuation and investment.
Control of Navigation

Although individual case-studies on navigation have been discussed, interviews with the students highlighted other, useful, information and therefore a cross-case analysis was conducted to draw out this information and tie it to the case study analyses.

Navigational control allows the learner to choose where they wish to go, moving freely through a program, rather than progressing in a lock-step fashion. Some of the students (particularly those working alone) tended to take an exploratory approach to the navigation. This is reflected by their comments in the interviews:

*Fairly self-explanatory program, very easy to use. I went around and had a look at all the rooms first, and found what was in them and then went back to the beginning and had a look at all the information and the background on the stocks and looked at the obvious things and did the tutorials* (Ted interview).

*You were given the freedom to go where you like and when you like. I just found some of the things that were put in there like the tv screen and the phone ringing and the fact that you could go where you liked really good* (Jon interview).

*What I was expecting was a step by step guideline which told you to go into this area and then this area and then this area, whereas we were testing it and finding out where to go. I’m a person who likes everything laid out before me because I don’t want to make any mistakes so I found it offputting at first, but in the end I found it didn’t really matter where you went because the computer program allowed you to go to all different areas which made it much more interesting. In the end I was becoming more comfortable with it* (Jean interview).

Each of these three students reported different benefits of having control. Jon enjoyed the freedom, Ted liked the fact that he could explore the whole program to give himself an overview, before going back and using it in an in-depth fashion, and Jean was initially disconcerted, but found that she gradually adjusted to the level of control and became comfortable with it.

Having control of navigation allowed some of the students to satisfy their curiosity as to what the program contained. Mark gave a good example of this in his interview:

*We used the map on the wall and a little bit with the booklet, but it was pretty simple to get around. I like clicking on everything to see what happened. I wanted to explore, but Simon would have read*
some things first and then had a look round. Anyway, he let me explore—it was a pretty fun thing (Mark interview).

Mark’s comment here was the only one that highlighted any difference any of the individual collaborators may have had in the way they would have liked to have completed the program. Mark wanted to take an exploratory approach, whereas Simon wanted to progress through the program in a much more orderly way. However, he bowed to Mark’s wishes and quite enjoyed the process, as evidenced by his interview comment:

I wanted to do the program in a logical way, but Mark wanted to explore. I wasn’t too fussed so I went along with him and found that I actually quite enjoyed getting the big picture first. It helped me put the whole thing together (Simon interview).

This comment highlights the fact that Simon would have taken a very different approach, but being in a collaborative situation enabled him to get a different perspective on the process of using the program.

Some of the students found that having to work out how to navigate through the program helped them learn about how the stock market environment worked, for example:

Just simply having to find our way round made us realise we’d have to look a bit (Greg interview)

Having to find our way round was definitely a plus in terms of learning what happens (Jean interview).

I found that I, by wandering around clicking on things I could see how all the different elements of the stock exchange are connected. I always thought it was a bit overwhelming, but I can see now that it is like a little mini-society with lots of bits all dependent upon each other (Jon interview).

I could finally see how it all connects. Why doesn’t the lecturer do something similar in lectures? Like draw a picture showing how the stock exchange all fits together. I need to see things in pictures to understand how they work (Ted interview).

These four students have found that, like Simon, navigating through the program allowed them to get an overview of not only the program, but also the environment being simulated. Ted referred to the fact that he needs an image to help him invoke a mental model of how such an environment fits together and works.
Control of navigation then, is important, not only from the point of view of giving students the freedom to move randomly and at will through the program, but it also has an important effect on their mental model of the environment.

**Level of experimentation**

As mentioned previously, one of the elements necessary to motivate and engage adult learners is active mental participation (Watson, 1969). The inclusion of discovery learning and inferential experimentation in *Principles of Financial Investment* allowed the students to adopt different strategies for acquiring their knowledge, and allowed for non-linear progression through the program.

By the act of experimenting with the program, the students became engaged in the content, leading to levels of immersion and flow. These were also enhanced by the ability of the students to choose their own paths through the program. All the students developed a pattern within the program, and in some cases, this pattern became a type of rhythm which the students described as a logical way of approaching the program, as shown by the following examples:

* Tutorials, then the Broker to buy stocks, then stock exchange to see what was going on. In the end we thought through a logical way of doing it (Jean interview).

* It was a logical sequence, when I found out that the tutorials were there, I thought I should do them first and then proceed to find the information about the various companies and go about buying shares. I could have bought without doing the tutorials, but I would have felt a lot more apprehensive about doing it without doing the tutorials (Jon interview).

* By the end we had a format, it was logical, we did everything in the same way (Mark interview).

Although the students felt that they had discovered the "correct" and logical way of progressing through the program, this was not what was expected. The program was designed in such a way that students could randomly move through it, sampling bites of information as necessary and from a variety of sources, particularly as the need for scaffolding reduced. In fact, although the students experimented to a limited extent in Quarter 0, their levels of experimentation were not as great as they could have been, as exemplified by the following comments:

* I think we just fiddled around and tried different things until we got some sort of pattern. It really was a bit random at first (Greg interview).
Almost as soon as I got into the program I could see a logical progression. Tutorials, then Broker and invest, then office and check progress (Marie interview).

I spent a bit of time experimenting and then decided on what I thought was a logical way of going for me. Sometimes I changed the order I did things, but mostly, after the first couple of quarters, I went the same way (Mark T interview).

All of the students eventually developed consistent patterns of usage that may have proved a limiting factor in the acquisition of information and development of problem solving strategies. However it should be noted that automacity can decrease impositions on working memory causing higher engagement (Farquhar & Surry, 1995), therefore, although changing the format of the program from quarter to quarter could encourage more exploration and experimentation, it was felt that for the sake of consistency and the development of automacity, the basic format should be left as it was.

Discussion

Nearly all the students developed a pattern of usage with the program, however the patterns were quite varied across the groups. All of the dyads went immediately to the Institute and enrolled in tutorials, but then the patterns began to diverge. Two of the groups went to the Stock Exchange and primarily used that information to make their initial buy/sell decisions. After this they went in different directions with one group (Mark and Simon) going to the Stock Exchange periodically, and the other group (Jean and Greg) doing tutorials interspersed with visits to the Broker. Karen’s and Bill’s pattern also included visits to the Stock Exchange at regular intervals, where they reviewed the comments of Sean and Wanda, but didn’t necessarily agree with what they read and heard. Mick and Sharni developed a strong pattern after the first quarter which involved moving between the Broker’s office and their own office.

The singles also used different approaches to the learning environment. Only Marie went straight to the tutorials, with Mark T and Ted taking an exploratory approach, browsing to orient themselves to the program. Jon, on the other hand, went straight to the Broker’s office and began digesting the reports, and then browsed before going to the Institute and enrolling in all the on-line courses, one after the other. Both Jon and Marie utilised the modelling provided by the on-line characters from
time to time, but Mark T moved mostly between the Broker and the office in a fairly linear way. He was also the only student who did not enrol in any of the tutorials, instead relying almost exclusively on material available in the Broker's office, occasionally supplemented by the company reports in the library. Ted, however, bought and sold for two quarters relying solely on information available in the Broker's office, before deciding that he needed more formal theoretical information and enrolled in the tutorials. However, unlike the other students, he did not enrol in one after another, preferring instead to complete a tutorial and then move back to the game for a quarter. He did this for each tutorial, thereby establishing his own, unique, pattern.

Although there was no correct way of completing the program, a clear division between the ways in which the pairs and the singles navigated was found. During the initial acquisition and mastery phase the students took very different paths through the program, during the extension and clarification phase the students' navigational routes began to converge, and during the investment and testing stage very similar patterns began to emerge. With some minor variations, and, with the exception of Ted, the dyads and the singles developed similar usage patterns after the first three quarters, where they tended to move between the Broker and their own office, making their buy/sell decisions and then getting feedback almost immediately.

The program, therefore, offered a path that, despite its diversity, allowed students to settle into a pattern that they found logical and comfortable. However, it was not expected that all students would follow nearly identical paths, although a wider cross-section of students may find that this no longer holds true. Analysis of student videos and audio tapes shows that the students, although choosing similar approaches to the organisational process of testing ideas, selected different heuristic, control and learning strategies, pursued different means of independent inquiry, and utilised different social aspects (such as scaffolding and hints). The similarities between the groups occurred towards the end of the program use and were in their sequencing and acquisition of feedback. This may have been due to the fact that the program structure led the students naturally towards a common sequential pattern, although Ted was an exception to this pattern, proving that the program could be completed in a different way. There was no evidence to suggest that the students
would have performed better had they chosen a different learning sequence or control strategy, although this would be a useful area for deeper investigation.

The descriptions of their usage highlight some important differences: decision making processes, use of tutorials, use of physical environment, level of experimentation, and control of navigation.

**Information Access**

In order to find the information required to solve the problems, the students had to access a variety of sources. Some of the sources gave multiple perspectives on the information and some gave information that was not appropriate to the tasks. The students had to find the information which would help them to solve the formulaic problems and make investment decisions. The students were presented with information from which they had to sift the relevant from the irrelevant and make decisions. Several comments suggested that the environment helped them find the information and sort it in a way which facilitated the problem solving, as evidenced from the following comments:

*The program is very well done. It's got company reports, Broker's information leaflets. They help you gaze into the future* (Jon interview)

*I found that I had to find the information, interpret graphs, listen to phone calls, watch the news—there was information everywhere. It was so like real life. But there was enough there to make the decisions and the places where I found it were very logical* (Ted interview)

*We looked at a lot of the reports, we looked at them more and decided what shares we'd buy, rather than looking at the current share prices. We relied more on information we found in the economy and the market. There were some warnings which were very good, like the discounted cash flow calculation for share prices is not what's used by shareholders. You tend to look for capital gains rather than a cash flow situation* (Bill interview).

*... before I invested the money I had to analyse the information before making decisions* (Mick interview).

These students were able to distil the information they required from the multiple sources and in this they were aided by the environment, in that the locations of the information replicated the information sources the students would need to access in real life. In other words, the realism of the environment helped provide an
understanding of the interrelationship between the components and helped the students to develop a relationship between the theory and the application.

A comparison of the time students spent in active information seeking is made in Chapter 8.

**Use of tutorials**

As stated earlier in the section on navigation, the tutorials were used more extensively by the pairs than by the students working alone. This has been attributed to the effects of collaboration—the students were able to support and coach each other through the material. The singles, however, found that the tutorials did not engage them for very long, possibly because of the format.

A review of all students using the tutorials showed that they used them in a way that was separate from the rest of the program. They enrolled, read through the material and completed the exercises in the tutorials, exited them and did not return. None of the students or student pairs reviewed the material in the tutorials once they had exited. Although this material was freely available in the filing cabinet in the office, students accessed it only during unstructured browsing. This has led to a complete rewrite of the way in which the tutorials are presented. Instead of three long tutorials which are disconnected from the six stocks being available at the beginning of the program, six tutorials will be introduced, one per quarter, and they will reflect the world events in that quarter and each will be written around each of the six stocks. In this way, there will be one tutorial per stock, per quarter. It is hoped that this will help bind the theory to the practical and encourage the students working alone to spend longer in the tutorials.

Observation of students using the program through the videotapes revealed that the tutorials appeared to be more engaging for the pairs because they provided a setting for discussion where learners could talk each other through the theory, coaching and supporting the other, discussing the formulae, and reflecting on the meaning of some of the content. Much of the time the dyads spent working through the tutorials was spent arguing about the meaning of some of the tutorial material, and also relating the information back to their formal classes. All the dyads, at some point in their discussions, mentioned information they had learned in other business units, transferring that knowledge to their learning in this program. Many were also
observed to relate the performance of their stocks in this program to recent events in the real world, blurring the lines between reality and fantasy.

The singles who used the tutorials, very quickly became bored with them, possibly because they did not have the ability to transfer the information from other units and because they lacked the support of a partner. Video evidence suggested that they simply worked through the on-line exercises rather than reflecting on what they meant and where they fitted into the investment scenario.

Only one dyad and two single students used the third tutorial, although their visits were all eleven minutes or less, meaning that none of these students covered all the material contained in tutorial 3. Several others looked at the objectives which were available pre-enrolment and decided that it did not contribute much to their decision making ability. This was a weakness of the program which will be rectified in a subsequent version. Although several students took the free “What do you know” test, it was not utilised as much as expected. Follow up interviews highlighted the fact that students would rather receive authentic assessment—in this case in the form of profits or losses, and in fact, this is what the majority of students did.

Time in modules

In order to be both active and reflective, students needed to take time to explore various components of the program and to think about the actions and processes necessary to determine problem solving and heuristic strategies (CTGV, 1991). Time spent in various parts of the program was deemed to be important so that students would explore the various areas and think about the information before acting upon it. Table 6.2 below shows the difference in the time spent by each student or student pair in the various sections of the program. Analysis of the videos showed that the paired students spent the bulk of their time discussing the various elements, in silent reading or reflective thinking.
Chapter 6

Using Principles of Financial Investment

Table 6.2. Actual time spent in the program by all the students

<table>
<thead>
<tr>
<th>Reception</th>
<th>Stock</th>
<th>Office</th>
<th>Viewing</th>
<th>Tut Library</th>
<th>Buy/ Sell</th>
<th>Broker</th>
<th>What do you know</th>
<th>Tut</th>
<th>Hints</th>
<th>Between Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simon &amp; Mark</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>Karen &amp; Bill</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>36</td>
<td>18</td>
<td>2</td>
<td>30</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>29</td>
<td>15</td>
<td>11</td>
<td>19</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>1</td>
<td>0</td>
<td>13</td>
<td>4</td>
<td>15</td>
<td>15</td>
<td>9</td>
<td>20</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Marie</td>
<td>1</td>
<td>1</td>
<td>18</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>19</td>
<td>0</td>
<td>23</td>
<td>4</td>
</tr>
<tr>
<td>Jon</td>
<td>4</td>
<td>0</td>
<td>15</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>24</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Mark T</td>
<td>1</td>
<td>1</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td>Ted</td>
<td>2</td>
<td>1</td>
<td>22</td>
<td>6</td>
<td>7</td>
<td>15</td>
<td>6</td>
<td>16</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

Although the program contained multiple representations of the finance content in an attempt to appeal to as many different students as possible, it was the vastly different approaches taken within the program by the paired students and the single students that was interesting and surprising. Table 6.3 shows the percentage of time spent in each area by each dyad and the single students and also shows the average time spent by each grouping:

Table 6.3. Percentage of time spent in various areas of the program

<table>
<thead>
<tr>
<th>Tutorials</th>
<th>Viewing</th>
<th>Office</th>
<th>buy/sell</th>
<th>Library</th>
<th>Broker</th>
<th>Reception</th>
<th>Stock</th>
<th>Browsing</th>
<th>Hints</th>
<th>Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen &amp; Bill</td>
<td>64</td>
<td>4</td>
<td>9</td>
<td>2</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mark &amp; Simon</td>
<td>21</td>
<td>13</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>22</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>39</td>
<td>4</td>
<td>14</td>
<td>10</td>
<td>16</td>
<td>15</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>57</td>
<td>1</td>
<td>6</td>
<td>10</td>
<td>13</td>
<td>8</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pairs Average</td>
<td>45.25</td>
<td>5.50</td>
<td>9.50</td>
<td>8.75</td>
<td>15.25</td>
<td>11.50</td>
<td>2.25</td>
<td>0.75</td>
<td>1.00</td>
<td>0.25</td>
</tr>
<tr>
<td>Mark T</td>
<td>0</td>
<td>5</td>
<td>21</td>
<td>31</td>
<td>1</td>
<td>36</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Marie</td>
<td>11</td>
<td>7</td>
<td>21</td>
<td>23</td>
<td>1</td>
<td>28</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Jon</td>
<td>23</td>
<td>7</td>
<td>16</td>
<td>9</td>
<td>9</td>
<td>26</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Ted</td>
<td>20</td>
<td>6</td>
<td>25</td>
<td>16</td>
<td>6</td>
<td>18</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Singles Average</td>
<td>12.00</td>
<td>4.75</td>
<td>21.50</td>
<td>20.75</td>
<td>4.26</td>
<td>28.00</td>
<td>2.00</td>
<td>0.75</td>
<td>3.25</td>
<td>2.75</td>
</tr>
</tbody>
</table>

As can be seen from Table 6.3 the total average percentage of time spent in various sections of the program varied between the two main student groups—the pairs and
the singles. The pictorial representation shown in the graph below highlights the differences more clearly (Figure 6.1).

![Graph comparing the average of actual time spent in each module by pairs and singles](image)

The main variations in Figure 6.1 are in the way the students used the tutorials, the buy/sell screen, the library, the Broker, the hints and browsing. Similar times were spent in the viewing room, the reception, and the stock exchange.

The student pairs spent, on average, more than three and a half times more time in the tutorials as the single students. This was a surprising outcome of the study as it was expected that all students would spend roughly the same amount of time in the tutorial section. Watching the videos of the students using the program, it became obvious that the tutorials were more engaging for the pairs because they could talk each other through the theory, coaching and supporting their learning. The singles who used the tutorials very quickly became bored with them, possibly because they did not have this support. The singles, however, spent nearly three times as much time in the Broker’s office than the pairs, and it was in here that they acquired their theoretical knowledge. The theory given in the Broker’s office was in the form of reports which presented the information in a succinct way and was much more practically oriented than the tutorials, in that it related specifically to the stocks.
available for acquisition and the current market conditions. Students were still guided through formulae and valuing principles, but the singles, with no collaborator, found this approach much more engaging.

The pairs gleaned their practical information on the stocks from the library which housed the company reports. Again, this was surprising, as it was expected that both groups of students would utilise the company reports with equal frequency. It is assumed that the pairs used the company reports heavily because the information therein worked well in conjunction with the tutorials, and having completed the tutorials they, unlike the singles, did not rely heavily on the Broker’s advice.

The amount of time spent in the buy/sell screen was also markedly different, with the singles spending nearly twice as much time in this area. Transcripts of the video tapes showed that the pairs spent some time in the library and tutorials, some time talking about their investments (mix and amounts), before going to the buy/sell area. However, the singles generally went directly to the buy/sell screen and then performed their calculations spending quite a bit of time moving between the buy/sell screen and the Broker’s office confirming their information and utilising the Broker’s advice and economic forecasts.

The singles spent more than twice as much time on average browsing than the pairs, who browsed very little. Review of the tapes showed that the pairs were able to talk to each other about where to go next and what they might find there, whereas the singles moved around looking and investigating the various aspects of the program. The other area of the program utilised more heavily by the singles was the hints. These were only accessed for a total of one minute by one of the pairs, but all the singles spent time accessing them in various areas. Again, it is assumed that this is because they used the program as a collaborator, seeking advice, support and coaching from the program.

In order to make good investment decisions, the students needed to have a grasp of theoretical aspects such as discounted cash flows, annuities and perpetuities, understand how to apply discounted cash flows to the valuation of shares under various conditions, and estimate required rate of return. All this theoretical information was presented in the tutorials, but it was also available, in different forms, elsewhere in the program. The students who did not complete an in-depth study of the tutorials did not appear to gain as deep an insight into the share
valuation process as those who did, but they would still have enough theoretical information to complete their share transactions successfully. This is evidenced by Table 6.4.

Table 6.4. Comparison of time spent in tutorials with final profit

<table>
<thead>
<tr>
<th></th>
<th>Time in Tutorials (Mins)</th>
<th>Final Profit ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen &amp; Bill</td>
<td>66</td>
<td>39,345</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>63</td>
<td>35,239</td>
</tr>
<tr>
<td>Mark &amp; Simon</td>
<td>21</td>
<td>23,500</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>35</td>
<td>22,080</td>
</tr>
<tr>
<td>Marie</td>
<td>9</td>
<td>26,000</td>
</tr>
<tr>
<td>Jon</td>
<td>23</td>
<td>28,890</td>
</tr>
<tr>
<td>Mark T</td>
<td>0</td>
<td>13,540</td>
</tr>
<tr>
<td>Ted</td>
<td>19</td>
<td>17,250</td>
</tr>
</tbody>
</table>

Table 6.4 shows that, generally, students who spent the most amount of time in the tutorials made the most profit. The exceptions to this are Mick and Sharni (who spent a lot of time compared with their profit) and Marie (who spent very little time compared with her profit). Mick and Sharni made less money than Jon, Marie, and Mark and Simon although they spent longer in the tutorials. This may have been because their background in finance was, with the exception of Ted, the least strong. Mick and Sharni were both in their first semester at University and had the most difficulty with the program (their problems are described more fully in chapters 7 and 8). Marie made a reasonable profit in spite of spending very little time in the tutorials and this may have been because she actively sought out the information she needed from other areas in the program, and was seen to be reflective—calculating net present values and discounted cash flows.

Although the students spent different amounts of time in different areas of the program, some areas were more informative than others. The most useful, but most technically difficult, information was in the tutorials and this information was supplemented by the company reports in the library. The Broker's office also contained very useful information, relating directly to the stocks and reflecting world events, and this was a fairly heavily utilised area by most students. The least
informative area was the viewing room which was, surprisingly, moderately utilised by both groups of students. This may be because Sean and Wanda were located in the viewing room and some of the students found their modelling to be quite useful. However, even students who did not access Sean and Wanda, spent time in the viewing room accessing share prices, although this information was available in the students' portfolios.

Table 6.2 shows the breakdown in actual times spent by each of the student pairs or singles in the total program. When viewing the pairs, Mick and Sharni spent the least amount of time completing the program. Whilst not thought to be a significant variation, this may be due to a number of factors—as stated earlier, they were the only pair to be in the first year of their degree and were less experienced with computers and the finance concepts, and they participated in the pilot study and completed the program just prior to exams, which meant they had considerable time pressures. The other three pairs completed the program in their holiday time and spent a similar amount of time in the program, although they utilised different aspects of the program as can be seen in Table 6.1.

An interesting outcome of this analysis was the total time spent in the program. No constraints were placed on how much time was to be spent on the program, nor was any guidance given, except that the students were all told to only complete three quarters (as this was a prototype only the first three quarters were completely finished, although there was a lot of information in the subsequent quarters). The students worked until they felt they had completed the program to their satisfaction, which, generally, meant that most of them ignored the instruction to only complete three quarters, and, in fact, tried to complete the six quarters. Although, as has already been shown in earlier sections of this chapter, the student groups took vastly different approaches with the program, the average total time variation between the pairs and the singles was only 13 minutes. Given that the total time spent by all students in the program was nearly thirteen hours, it was expected that the time variation would be much greater.

The following case-study analysis of each dyad and single student highlights the differences in the times each spent in the various modules of the program.
Karen & Bill

As evidenced by the following graph, Karen and Bill spent the bulk of their time in the first two tutorials, and they also spent a substantial amount of time in the library.

This amounts to over eighty percent of their time looking for information, acquiring new information, and—when evaluating their talk—making decisions and solving problems based on that information. Only thirteen percent of their time was spent in the other two information rich areas (the office and the viewing room), and two percent of their time was spent in the buy/sell area. From this, it can be surmised that Karen and Bill had made their buy/sell decisions prior to going to this area and this is why they spent so little time trading.

Jean & Greg

Jean and Greg spent almost no time browsing, instead they discussed where to go next and then moved straight there. Figure 6.3 illustrates the percentage of time spent in each activity:
Jean and Greg spent 74% of their time spread over tutorials one and two, the library, the buy/sell screen and the Broker. The rest of their time was divided fairly equally between the other modules.

**Mark & Simon**

Simon and Mark spent considerably less time in the tutorials than the other pairs, but spent a lot more time accessing the other sources of information, such as the quarterly reports and Sean and Wanda. They also spent considerably longer moving about in the program and it took them much more time to get into a routine than the other students.
Simon and Mark spent the bulk of their time in the Broker’s office, tutorials 1 and 2, the buy/sell screen, the library, viewing room and office, amounting to a total of 92% of their time. Unlike the other pairs, they tended to move around more and spend shorter periods of time in more modules.

**Mick & Sharni**

The following graph (Figure 6.5) shows the percentage of time Mick and Sharni spent in each activity. They are the only students who had trouble finding the warp mechanism. This was not as a result of reluctance to explore, they moved freely round the environment, but it was purposeful exploration rather than casual browsing and they simply did not recognise the clock as being of significance.

Mick and Sharni did not spend a large amount of time in the tutorials, instead they preferred to rely on the advice of the Broker.
Marie

The graph below shows the percentage of time Marie spent in each area.

Marie moved around a lot and this may have been due to a lack of confidence in her knowledge of the material or the way the program worked. As can be seen from Figure 6.6, she spent quite a lot of her time in the office, the Broker and the buy/sell screen, using the information contained in these areas, planning her investments and
checking the outcomes. She spent very little time in the library and only 5 minutes (or 6% of her time) in the tutorials. This lack of a fundamental theoretical base may account for her lack of confidence in making the investment decisions.

Jon

The graph below shows the percentage of time Jon spent in each area and it is interesting to note that unlike most of the other students, he visited every area and spent some time in each one.

Mark T

Figure 6.8 below highlights the fact that Mark T spent 88% of his time within three main areas: the Broker's office and buy/sell screen, and his own office. He spent a substantial amount of time moving between the reports in the Broker's office and the buy/sell screen, using them to guide his investment decisions.
Figure 6.8 Percentage of time spent by Mark T in each module of the program

Figure 6.9 Percentage of time spent by Ted in each of the media elements

As evidenced by the graph in Figure 6.9, Ted spent his time distributed fairly equally between most of the modules in the program. He spent relatively short periods of
time in the tutorials, instead gaining his theoretical information from the Broker's office, the library and the office.

**Summary**

The interviews with students highlighted the fact that they used *Principles of Financial Investment* differently from their traditional learning materials. Instead of simply accessing information, they were forced to find it, interpret it and then experience using it. In this way the students, the information and the interface were integral.

In the course of working through the program the students were exposed to processes, outcomes and actions.

Most of the students took an exploratory, non-linear approach to navigation, generally finding the interface intuitive and interesting, and several mentioned making the connection between the game and the real world, which also seemed to aid them in creating mental models of the environment. The formation of mental models is useful in assisting students in navigating through the environment, and most of the students found this easy and undemanding, with no memorisation of how to navigate required.

All the students developed patterns of usage, but these tended to vary considerably. The single students and dyads used markedly different approaches, spending different times in different areas of the program. The collaborating dyads used the tutorials more extensively than the single students, and all students used them as separate from the game, rather than an integral part of the whole program. Not one student fully utilised the three tutorials and "What do you know" section.

The advantage of using an immersive interactive learning environment such as the *Principles of Financial Investment* is that content may be covered in as much detail as in a traditional, didactic setting, at the same time encouraging students to collaborate either with each other or with elements contained within the program. The dyads generally found their use of this program to be an engaging and exciting way of learning, developing their critical thinking skills and improving their understanding of the whole process of financial investment theory. This form of learning and activity was far less evident among the independent learners and suggests the need
for those seeking to implement and design similar forms of computer-based learning to consider collaborative use as a key element of their design.

**Conclusions**

The students used the program, *Principles of Financial Investment*, in ways that suggest some design considerations for future interactive learning environments. For example, an interactive multimedia microworld should be designed in such a way that it works effectively for both collaborating students and students working in isolation. To achieve the desired result a number of factors should be put in place. Firstly, whilst the physical learning environment should provide a degree of comfort in its use to all learners, it must nevertheless have some small elements of the unknown. The unknown or disorientation, by necessity, leads to experimentation and exploration, and once properly undertaken, the learners gain from the experience in that they become aware of, and comfortable with, the relationships between the components offered by a program. Whilst, on the face of it, navigation guides and content descriptions to the use of a program can be provided by materials separate to the program itself (for example, information or instruction booklets) it is clear that most learners do not avail themselves of the opportunity provided. If a program needs to contain guides or clues, such aids need to be built into the program itself and be readily accessible by the learners within the process of exploration.

Secondly, the interface should be intuitive, logical, realistic and interesting, so as to facilitate or aid the process of exploration. Low level point and click interactions evident in much multimedia, should be kept to a minimum. The successful interaction between a learner and a program's interface is of critical importance in that it is the only means by which the learner can connect with and control the operations of the program. In the creation of a program, it is suggested that there must be a successful coupling between the use within the interface of "real life" terms that learners are readily familiar with or can relate to (for example, in the area of finance, use of words such as "interest rates", "inflation", "GDP", and "share listings" would seem appropriate), and the use within the interface of realistic, interesting and perhaps surprising iconic auditory and visual features (for example, props such as tvs, phones and filing cabinets, as used in this program). If a program can achieve such an interface, then the desired dissemination of information or the
desired learning outcomes can be achieved almost incidentally. The interface, by its very design, should directly involve the learners in the process and assist the learners to relate to the content. In so doing a sense of two-way communication is created and the content becomes more relevant and meaningful.

Thirdly, a program should be designed in a way that readily allows for navigation patterns that are flexible, varied, logical and suited to particular learners or learner groups. It is clear from the study that there were substantial differences in the ways in which the learners used the program, and that learners preferred to choose their own path through a given program rather than the path being prescriptive or predetermined. Given the choice, learners will develop a pattern of navigation which for them represent the logical and comfortable way of approaching or progressing through a program. To be successful, the program should accommodate both single learners and collaborative learners and also varying learning styles. To achieve the foregoing, a program’s development should provide navigational freedom and should accommodate ready transition to, from and between areas contained within the microworld. All learners or learner groups come to a program from different backgrounds and with differing levels of skill and knowledge. Whilst a program should allow the learners not only to embark upon the journey from different starting points, it should also provide the required information through a variety of representations and sources and it also should readily allow many stopover destinations and for various periods of time. Whatever the path, a program should allow all learners to set their own achievable goals whilst not impeding the overall learning outcomes which have been implicitly set by the program itself. Regular, authentic feedback elements built into a program are seen as critical in facilitating the above.

Fourthly, information or content should be provided within a program through multiple sources set in a realistic environment. If multiple sources are in place, all learners, whatever path is chosen, are able to access sufficient critical information or content to make informed decisions. To maintain learner engagement (and especially so in the case of learners working alone) it is suggested that long theoretical and technical tutorials should be kept to a minimum in any program development. To supplement the provision of information, long tutorials (if any) should be supported by, or be replaced by (as the case requires), more frequent shorter tutorials that are
directly and inextricably linked to the practical aspects of the program with authentic assessment and feedback being instantly provided therein.
Motivation and Engagement: Analysis and discussion

This chapter looks at how the learners being studied used a multimedia program designed to appeal to adult learners and incorporated the "eight motivational learner effects" outlined in Chapter 3. Chapter 4 described the implementation of the program with business students and Chapter 5 discussed the methodology by which the data was collected thus enabling the research questions to be analysed.

This chapter looks at the results of the qualitative data collection and analyses that data in an attempt to determine:

2. In what ways were the eight motivational learner effects achieved?

Evidence of the eight motivational learner effects was derived from analysis of interview responses, the video tapes of students using the program, and the audio tapes of the collaborating students' talk.

Method of analysis

The data for analysis was collected by observing students interacting with the program, audio taping their conversations and interviewing them after they had used the program. A total of twelve learners were studied, eight of whom worked in pairs, and the other four worked alone. Data collected from both the pilot study and the main study was used in the analysis. The interviews and videotapes were transcribed and coded using the NUD•IST program.

The responses in these nodes were then grouped to identify themes and to link ideas and construct theories about the data. These themes were then drawn together to create a thick description (Patton, 1990) of what occurred and to draw some conclusions. Although there was overlap in some areas (for example, immersion/flow; and immersion/fantasy), there were sufficient differences to keep the areas separate. The final breakdown of learner effects and behaviours is outlined in Table 7.1 below. Table 7.1 provides a description of the intended learner effects and the learner behaviours which indicated their respective occurrence and
presence. The behaviours were drawn from observations of students performing with the program and were coded as sub-categories.

Table 7.1. Division of data in categories and sub-categories

<table>
<thead>
<tr>
<th>Main Nodes (Learner effects)</th>
<th>Behaviours</th>
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<tbody>
<tr>
<td>Immersion</td>
<td>Focussed engagement</td>
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<td></td>
<td>Environmental engagement</td>
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<td></td>
<td>Emotional engagement</td>
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<td>Cognitive engagement</td>
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<td>Reflection</td>
<td>Dealing with conflicting advice</td>
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<td></td>
<td>Synthesising feedback</td>
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<td></td>
<td>Putting theory into practice</td>
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<tr>
<td>Flow/Play</td>
<td>Loss of self-consciousness</td>
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<td></td>
<td>Enjoyment</td>
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<td></td>
<td>Protracted engagement</td>
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<td>Collaboration</td>
<td>Scaffolding learners</td>
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<td></td>
<td>Coaching partners</td>
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<td>Learner control</td>
<td>Control of Pace</td>
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<td></td>
<td>Control of Time</td>
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<td>Control of Process</td>
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<td></td>
<td>Handling multiple perspectives</td>
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<tr>
<td>Curiosity</td>
<td>What-if activities</td>
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<td></td>
<td>Sensory inquiry</td>
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<td>Fantasy</td>
<td>Blurring of reality and fantasy</td>
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<td></td>
<td>Forecasting</td>
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<td>Challenge</td>
<td>Understanding the goals</td>
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<td></td>
<td>Achievable goals</td>
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<td></td>
<td>Outcome uncertainty</td>
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The conversations of the collaborating pairs were analysed by counting the number of times their talk reflected each of the eight learner attributes. Sometimes their conversations would cut across two or more of the categories, and in these cases the utterances were counted more than once rather than trying to classify them into one particular category. No allowance was made for the length of the conversations, rather the incidences only were counted. The audio tapes were then looked at in conjunction with the video tapes so that non-verbal language such as pointing at the screen, silent reading and writing down information could be noted. This was considered to be important, particularly when measuring the extent to which the students were immersed, as well as reflective and collaborative time. As there was no audio-taped data for the students working alone, the video tapes were analysed for incidences of the eight learner effects. However, it was not possible to identify all the learner effects from non-verbal body language. In order to measure the extent to
which these four students experienced the eight effects, greater emphasis was placed on the interviews.

The following sections describe the outcomes of the data analyses which sought to explore the extent to which the program created the various effects deemed necessary to motivate and engage the learner.

**Immersion**

Learners are immersed when they demonstrate sustained periods of time in various aspects of an activity, and talk at length about what they are doing. In order to be immersed learners need to be engaged physically, emotionally and viscerally (Low, Venkataraman, & Srivatsan, 1994). Immersion can be identified among learners by the scope and extent of the engagement they exhibit when working with the learning materials. There are several forms of engagement which can be observed among immersed learners. These are emotional, focussed, cognitive and environmental engagement (eg Psotka, 1995).

Learners are emotionally engaged when they demonstrate positive or negative feelings about events occurring during their activities, such as enthusiasm, anger, frustration, disappointment, elation and so on. Learners exhibit focussed engagement if their talk or comments show that they feel like participants in the activity rather than users of it. Focussed engagement is also demonstrated by complete engrossment with a learning activity for an extended period, to the point where learners may not notice what is happening around them. Environmental engagement is exhibited when students demonstrate absorption into the activity and are attracted by it, and cognitive engagement is identifiable when students are on-task and are attending to new stimuli. All these forms of immersion were evident at various times with all the students.

**Focussed Engagement**

Students are experiencing focussed engagement when they have “willingly suspended disbelief” (Laurel, 1991), and are displaying active participation in the activity. Focussed engagement allows the learner to devote attention to whatever is novel in the environment which then leads to cognitive engagement (discussed later in this section) (Skelly, 1995).
There were many incidences of focussed engagement evident in the talk of students as they reflected on their use of the program in their interviews. Several students described the feeling of being active participants in the program, for example:

*I really felt like I was in a share environment. When I was in the broker's room, I felt like I was looking at a wall in the stock exchange* (Jean interview).

*The game was great, I felt totally in it, I could even relate to those cool Simpson's style characters* (Simon interview).

These statements suggest that the two students felt involved in the program to the point where what they were doing became believable to them. This willingness to accept another reality is an important factor of focussed engagement and necessary for immersion, as to be fully immersed, students need to exclude the real world and embrace a fantasy world (Psotka, 1993).

The reality of the program was also a factor which led students on many occasions to feel forms of focussed engagement. In the interviews following use, several students stated that the program setting was life-like, that the tasks they were asked to complete were valid and that they had a first person experience, for example:

*It was just like real life, we had to buy and sell based on what we'd learned and how we'd valued the stocks. I liked the fact that it was my office and they were my shares and I was in there in every sense of the word* (Marie interview).

Marie appeared to like the fact that the microworld was individualised and that she could invest something of herself in the learning experience. The individualisation and decision making allowed appeared to strengthen her engagement by providing a personal context and permitted her to feel involved in the activity.

Observation of student behaviours when using the program revealed that students were frequently absorbed in the activities they were asked to complete, appearing to experience a sense of ownership, and issues of time. On such occasions external distractions did not appear to be evident, for example:

*I looked at the clock when we were going through the tutorials and it was almost three o'clock and I'm thinking, woah, is it really that time because you want to get into it* (Karen interview).

*I felt like I was really there and the time just flew. I was completely immersed* (Ted interview).
There were repeated incidences of these behaviours exhibited at various times, and students frequently mentioned lack of awareness of time in their interviews. This aspect of program usage was a very strong indicator of focussed engagement and provided clear evidence of the program's ability to immerse the learners.

That the program appeared to be strongly engaging was evident throughout the observation periods. The students quickly became accustomed to the environment and setting and moved straight into the decision making process. The following two examples were representative of many comments made:

*Within the first ten seconds I was using the program and raring to go* (Ted interview).

*Right, click on the doors. OK, here we go, click on the register and let's start* (Mick talk).

The ease of use of the interface and the intuitive form of the navigation combined with the known contextual setting, all contributed to an environment which provided few impediments to use and progress. None of the students had any difficulty starting the program and appeared anxious to proceed.

The actions of Karen and Bill exemplify most others in this regard. They talked their way through the program, discussing formulae at length, arguing about the correct answers and treating the money as though it was real and it belonged to them:

*To be safe yeah, although of course what my valuation would say is that now is the time to buy Lion Oil because they can only go up* (Bill talk)

*Ok look at the economy, interest rates are high* (Karen talk)

*Are going up which is bad news for the stock market, and us* (Bill talk).

Mark had similar feelings as examples of his non-consecutive talk to Simon demonstrates:

*Don't know if I want to spend too much of my money on such a speculative share* (Mark talk)

*Could be wasting our money man, I think we should conserve a bit for the next few months, see where things take us* (Mark talk).

The discussion by Karen and Bill showed that they felt a sense of ownership, both in the program and of the money. Mark and Simon expressed similar sentiments in their talk, both groups of students thus exhibiting immersive behaviours.
Bill and Karen had a discussion about whether to enrol in one of the tutorials, stating “it’s only money”, highlighting the fact that they considered the money to be really theirs. Jean and Greg displayed similar feelings about “their” money; they also revealed an understanding that learning would be lifelong and that this learning would have to be paid for:

Is there like a thing that tells you how to do all this, before we actually do the test? (Jean talk)

Yeah, we have to pay for that don’t we? (Greg talk)

What do you mean, we have to pay for it? (Jean talk)

Well, I think, somehow it comes out of our money (Greg talk)

I suppose we’ll spend the rest of our lives enrolling in short courses to learn stuff so we might as well start now (Jean talk)

And our money! (Greg talk)

This sense of ownership of the money highlighted the fact that the students often forgot the fact that the money was not real and that there would not be any consequences if they lost it all. This highlights the fact that these students were truly immersed in the program.

This was evident on many occasions, with comments that illustrated that by paying for the tutorials, the students valued them more. This was borne out by a conversation which Sharni and Mick had:

Ok, are we going to pay $200 for this tutorial? (Sharni talk)
I guess so, it looks like we need what it’s telling us (Mick talk)
We’d better get our money’s worth then (Sharni talk)

Simon and Mark decided they could put the money to better use than buying further tutorials:

Look here’s a free thing that tests us on what we know (Mark talk)
Yeah, let's do that, if we can do most of it, let's see if we can learn the rest on the job, so to speak and save our money for making more (Simon talk).

These statements all demonstrate a sense of belief among the learners in the reality of the stocks and that the students believed the money and the stocks to be real and that they “owned” them. They show that the students also “experienced” the program and took the issues and their implications seriously. These factors are all
evidence of high levels of focussed engagement and were contributory to the immersion experienced by the students as they indicated a first person experience within an environment which was considered to be realistic and authentic.

Environmental engagement

When learners feel that they are part of the environment, they can become engaged with it. Environmental engagement is evident, for example, when learners point at the screen and read aloud to each other or themselves. Being engaged with the environment causes the learners to feel drawn into it, to become involved with it and attentive to it. Something in the environment needs to attract and hold their attention, and when they choose to attend to a stimulus that they deem to be significant, and to attend for more than a few fleeting moments, then they are said to be immersed.

Observation suggested that the degree of student engagement in the environment appeared to flow in part from, or was assisted by, the mimetic representation of a real world setting. Instead of talking about abstract events, students discussed going to the library to pick up information, going to the broker to invest and going to their office for more information:

*So, what's the story, shall we go to the broker and start investing? (Simon talk)*

*Um, I think we should go the library, check the company reports, then just see what the current state of play is in the quarterly reports, then do our investing (Mark talk)*

*Yeah, perhaps we should also see if there's a news update on the tv (Simon talk).*

And:

*Ok, I think we should check out the broker and the viewing room and get all the information together before we take the plunge (Mick talk)*

*OK. We can also look in the library for the company reports (Sharni talk)*

*Nah, they always beef up the company. You'll get a more real picture from the quarterly reports and the economic forecasts, then we can put it together...(Mick talk)*
It is clear that these students believed the information that was available in the environment and that they could relate it to their problem solving and decision making. Environmental engagement leads to immersion as the learner and the surrounds (the program) become one and in harmony, and not at odds or in conflict (Psotka, 1995; Skelly, 1995).

All the students displayed physical signs of involvement with the environment at various times, by pointing at the screen, reading aloud to themselves or to each other, noting important points, using their calculators to check formulae and displaying elation when they understood a point or worked out the correct answer to a formula. In this, the students were displaying both physical immersion with the environment and emotional engagement.

The program environment also provided the students with ethical dilemmas to solve. These were delivered via the telephone and several of the students asserted that they added a sense of reality to the program:

*hey, the phone's ringing, click on it and see what it does...Listen, that bloke's got a heart problem, he might die! What'll it do to the share prices? We'd better think about this* (Mark talk)

*[Expletive deleted] ... I think someone's giving us insider info. I think we should ignore it. Do you think we should? Who the hell is this person?* (Simon talk)

*We really tossed the insider info around. We were tempted by it. We thought we might get fined or something. I thought that it made it seem much more real than someone telling us about it and not to do it and what the consequences would be* (Simon interview).

*The insider trading stuff seemed real somehow. I got really caught up in it and worried about what would happen if I used it, then I worried about ignoring it, so in the end I decided to try and work out what would happen if I didn't know the information and would it make a difference* (Marie interview).

*I thought, with the phone calls, that if I acted on them that I would somehow go to gaol. I thought it might be like Monopoly, like, Go directly to gaol, do not pass go!* (Jean interview).

As evidenced by the statements above, the ethical dilemmas presented caused some concern for the students. They did not treat them as hypothetical, rather they behaved as though the telephone calls giving them the information was real, they took the calls seriously and discussed and thought about them at length, including...
the consequences of acting upon the information. These students, having detected the ethical issues, decided that they needed to respond to the problem in some way, either by ignoring them, discussing them and determining another strategy or course of action. The statements are indicative of the fact that the students became deeply involved in the scenario to the point where they suspended disbelief and seriously considered the ethical issues and their implications. This willingness to accept another reality is recognised as one of two factors dominant in predicting depth of immersion (Psotka, 1995).

The following comments attest to the fact that the students treated the ethical dilemmas seriously; they also demonstrate the degree to which the students are absorbed with the program, willingly suspending disbelief (Laurel, 1991) to the point where they forget that the subject of the phone call is not a real person:

*Does the telephone call amount to insider trading? (Bill talk)*
*Really not, insider trading is more to do with what’s happening in the company (Karen talk)*
*What’s the guy from inside the Reserve Bank? (Bill talk)*
*I don’t think it matters because the only thing that will matter if it does increase, well we’re not gonna go buy anything because we know they’re not gonna increase. We’re only making sure because we want...um, it’s still at 10% at the minimum (Karen talk)*
*Yeah, but if Frank carks it, Com Corp is depending on him (Bill talk)*
*But he’s not gonna die right now (Karen talk)*
*Yeah, well, they’re saying he’s a winding old soul and he’s got a heart complaint (Bill talk)*
*Your freak is going to die. I mean, he’s obviously living it up and he’s got a heart complaint (Bill talk)*
*I don’t think he’s gonna die within the next quarter though (Karen talk)*

And later:

*Yeah, he died in his sleep (laughs), heart failure through overexertion. Is there anything on the phone? (Bill talk)*
*I think we leave it for now. Its just after he’s dead so when somebody else might come in they might increase again. Look nothing’s changed. (Karen talk)*

Here the students debated the meaning of insider trading, by talking through the issues they their thoughts on the notion. Being presented with the concept in context allowed Karen and Bill to pin their thoughts on something real rather than an abstract concept presented in the lecture. The impact was such that once Bill and
Karen finished the program they continued to discuss the insider trading issues and the fine line between being given information ethically and unethically:

Ah, insider trading. I really think that’s a really hard part, a grey area of law (Bill talk)
What amounts to insider trading, it’s just normal (Bill talk)
Speculation (Karen talk)
Yes, or you know, do you call rumour, just getting a rumour from somebody, is that insider trading, or do you actually have to be told so that you’ll make a decision on it? Of course you’ve done this haven’t you? (Bill talk)
Yeah we did that, it seems strange to do it in accounting mainly, we didn’t take it seriously then, it was just a dry fact (Karen talk)

This conversation provides evidence of the fact that the students, even after completing the program, treated the content as if it were real and important to them. They grounded the discussion back to their previous knowledge acquired in Accounting and mentioned it as a “dry fact”. The subtle comparison with the way that the information was accommodated in the program infers that Karen did not see the presentation as “dry”, but rather something real and interesting. This is tangible evidence of the fact that these two students were immersed in the content matter.

Bill and Karen discussed, as if it were real life and it really mattered, the issue of whether speculation or rumour fell within the insider trading prohibitions. They acted as if they were players within the environment and not observers of the environment and to that extent the environmental engagement led to real immersion.

It was obvious that the ethical dilemmas had a big impact on every student as they all mentioned them in their interviews:

I think putting in little things like the insider trading, putting it in a fun thing like that makes you remember it more, rather than having it in the tutorial which is where we first heard it. This way it was in context and we put it in practice and I thought, yes I’ll remember that; and the same with the media releases (Jean interview)

Ethics, what shares were going to do, thought about having a balanced portfolio, rather than putting everything into a roll of the dice. The newsreader also told you that the CEO of the bank tipped that the interest rates were going to increase, then we’d have to increase the required rate of return. It got you thinking (Bill interview)
Chapter 7

Motivation and Engagement: Analysis & Discussion

Bill’s statement here suggests that he was absorbed, considering the consequences of events and his actions. Not only was he thinking about issues, but he was thinking about them in the context of the environment. It is clear that the authentic environment within which the ethical issues were created helped students to put them into context and thereby understand them. Not only was the environment able to capture the students’ attention, but it was able to hold it and provide an impetus for action, leading to a sense of immersion.

The underpinning realism described above also carried over to other parts of the program as several students alluded to the way in which the authenticity of the environment helped them synthesise their knowledge and kept them engaged:

*The whole thing was really well put together because you’ve got all the important bits like GDP and then the interest rates and inflation, plus all the share listings, plus you had background information, that’s the first thing you do when you buy and sell shares is look at past events which was all there* (Mark interview).

*I think the broker where you make a decision to sell or buy and eventually you go to the office and move to the next quarter and have a look to see what the results of your decisions were, the profit and loss part makes it real* (Marie interview).

*Some people say [in lectures], what the hell am I doing, I’m not sure what I’m going to use the information for in the future, but actually this has got to be real. You become more motivated because you know this is going to happen to you like this in real life.* (Mick interview)

*Very practical, everyone’s going to deal with shares and you have to know the system. This format kept me involved, it was like a story unfolding* (Ted interview).

These are some examples of the ways in which the students found that the realism of the environment helped them to stay involved in the program. The tight linkage between the sensory and functional elements of the program, was an essential component of engagement in this instance, as it allowed the students to believe that what they were doing was real and had meaning and relevance to their own lives. This in turn was evidence of immersion.

The literature suggests two psychological factors which are dominant in predicting depth of immersion; the first is the willingness to adopt another reality and make an effort to participate in it fully; the second is the ability to filter out the outside world (eg Psotka, 1995). As these factors were noted in the vast majority of cases for
substantial periods of time, it is asserted most of the students experienced immersion during their use of the program.

Depth of exploration and time in each module is also an indication of the degree to which students were engaged with the environment. These will be discussed fully in Research Question 2.

**Emotional engagement**

Direct engagement causes the learner to be directly involved in a mimetic world without being distracted by computer system interventions. Often second-hand knowledge which is generalised usually only appeals to the intellect rather than the emotions as it lacks "...the balance and completeness of experienced situations...Information communicated as facts loses all its contexts and relationships, while information communicated as ... experience maintains and nourishes its connects" (Bender, 1973 cited in (Laurel, 1991)). When learners experience an event, then, they are much more likely to be emotionally engaged with it than if they were to be presented with information or facts.

Emotional engagement is an important outcome of immersion, particularly when the students can experience the information. This view is confirmed by Heppel (1996) when he states:

> I'm interested in multimedia where I've got a role, and the role isn't just choosing whether I start it or stop it, or choosing the route or destination. It's me putting something of myself back into it.

Evidence from students' personal reflections on program usage tended frequently to suggest that they felt they were putting something of themselves into the program and provided evidence of what is called here, emotional engagement.

Most of the students had some expectation of success while fearing failure and this helped them to be engaged emotionally as they felt as though they were stakeholders in the environment. Although the students were aware that the environment was fictitious, with fictitious stocks, some of them mentioned that the representations were real enough to absorb them on a deeper level, for example, Bill and Karen showed evidence of this captivation with the representation, displaying elation at some of the stock price rises with words such as "sensational" and "wicked". Conversely they displayed disappointment at one of the stocks dropping:
ComCorp has dropped 20 cents. We didn’t really commit a hell of a lot (Bill talk)
It’s still a lot of money (Karen talk)
Yeah, I guess we did lose a bit didn’t we (Bill talk)

Simon got really upset at the losses incurred with DNA. He said “typical” and used several expletives repeatedly, and kept going back to check that the price was correct. He asked his partner, Mark, several times why the price had gone down so much. These highs and lows of emotions parallel the peaks and troughs readers experience when reading a novel, or viewers of movies might experience—they felt as though they are experiencing the fictitious events and could identify personally with them. Mark and Simon and Karen and Bill chose to attend to a stimulus that they consider to be significant (in this case expectation of success and fear of failure), and these emotions are immersing them in the program.

Expectation of success and fear of failure were not the only emotions that students experienced; a sense of efficacy was highlighted as an important attribute of immersion. In their interviews, Karen and Bill both reinforced the fact that they felt that they had the capacity to produce a desired effect:

...but with this you go into the office and you know what to do...because I don’t normally like computer games, you need something you can understand. My brother plays a lot of those strategy games and they just completely lose me, but this was intuitive. I think it was realistic, but it went further than reality and that made it more enjoyable (Karen interview)

Karen felt a sense of alienation from strategy games which did not provide her with a sense of efficacy. This is an important gender issue—female students are more likely to feel alienated from strategy games because they are written from a male perspective. However, research has shown that girls’ interest in strategy games will increase if they are given the opportunity to collaborate or solve puzzles (eg Inkpen, et al, 1994) Because Karen found this program intuitive and realistic she found that she enjoyed it more and derived pleasure from it. Bill also found the program intuitive and realistic, gaining a sense of spatial engagement:

The graphics are very good—you go through a door—very logical, so you had a graphical fix rather than just trying to click on some disembodied button or something, at least you imagined yourself in the stock exchange or imagined yourself in the Broker’s office (Bill interview).
Bill found that recognising objects increased his sense of identification with the environment, which in turn increased his sense of immersion in it. Simon found that he could really identify with the people in the program, which increased his sense of involvement:

*I really liked the funny people and the Simpson's style presentation. I really felt that I could relate to those weird haircuts (Simon interview)*

Simon stated that the people are what made the program appealing to him. Using people to increase valence is a well known technique for producing emotionally engaging software, as evidenced by comments made by (Skelly, 1995):

*If you want your interface to be as emotionally neutral as possible, you should avoid using faces in the interface (p. 11a).*

In the main, the students clearly felt that they had a role to play in the program, had a sense of experience, and could identify with the content, which increased their sense of pleasure in using it. These emotions not only held their attention, but increased their immersion.

**Cognitive Engagement**

Being engaged with the task is an antecedent of immersion, as when students are on-task and oblivious to distractions, they are engrossed in what they are doing. Task engagement and immersion have a spiralling effect on each other as the longer students are engaged on a task, the better their chances of mastery which in turn increases their positive feelings towards the program and leads to an increase of their engagement with it (Tomkins, 1970).

Evidence of absorption in the program was derived from analysis of student talk and videotapes of them using the program which showed that the vast majority of behaviour exhibited by the students was on-task. The students’ talk was transcribed into a spreadsheet and coded according to the behaviours identified in this chapter. Incidences of off-task talk were also noted. Off-task talk was determined to be any talk that was not related to the formal content of the program, or talk that was irrelevant to the task at hand (Henri, 1992).

The percentage of time on task is revealed by the following table which shows that the pairs’ talk was almost exclusively on-task during the time they were in the program:
Table 7.2. Percentage of task engagement talk by pairs

<table>
<thead>
<tr>
<th></th>
<th>% of time on task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen &amp; Bill</td>
<td>100</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>99.2</td>
</tr>
<tr>
<td>Mark &amp; Simon</td>
<td>100</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>97.8</td>
</tr>
</tbody>
</table>

The off-task behaviours of Jean and Greg and Mick and Sharni are more fully described in Research Question 3.

Most of the instances of off-task talk were beyond the control of students and caused by unexpected events. For example, there were two incidences of off-task behaviour caused by the system crashing and having to be restarted. Although failure of the technology is almost inevitable, it should be avoided at all costs as the students are then forced to interact with the system rather than the mimetic illusion of the environment, and this forces them back to “reality” thus breaking the immersion. Because of this fact, fine tuning of the system was considered to be an on-going project to proof it against crashes where possible.

Many examples of the students’ talk also made evident other forms of cognitive engagement. The students were observed frequently to treat the program and its content in a serious and deliberate fashion, often talking through their investment decisions and the implications at length before decisions were taken:

*I think we should get rid of some of those Diversify shares and make a profit because we bought them at 40 cents we earn 20 cents. We wanna go to our broker (Karen talk).*

*The price last quarter was $1.50 and they reckon it’ll still go down more but there are no indications on the Austbank. It seems a pretty steady stock and the company report confirms this (Greg talk).*

These forms of talk provided further evidence of the capacity of the program to encourage and support high levels of both cognitive and emotional engagement leading to frequent instances of immersive activity.
The representational context and realistic tasks helped the students' sense of immersion, the fact that they had something at stake, albeit "virtual" money, helped them to experience highs and lows of emotion.

We had our money which we had to manage and try to maximise. The way the whole program was set out helped us to imagine that we were in a stock exchange, buying and selling. It made us scared and happy at the same time (Jean interview).

We were thoroughly buried in it. Everything was so real that we really felt a flutter of excitement when we warped and checked how we'd gone (Sharni interview).

The two students above pointed to tasks or actions that they engaged in. Jean talked about imagining herself in the stock exchange, buying and selling, and Sharni talked about warping and checking her account balances. Both students described positive emotions that went with the tasks, increasing their engagement and immersion (Tomkins, 1970).

**Summary**

Engagement, in its many and varied, yet linked, forms is observed when the learner is immersed. Immersion is demonstrated, in part, by the time spent within and the degree of 'talk' involvement and discussion about the various aspects of an activity.

It is clear that at various times the students experienced the four types of engagement to various degrees. Focussed engagement appeared to be very strongly experienced by both the pairs and the singles. Both groups of students described the feeling of an alternative reality in which they became involved and experienced a sense of ownership, as well as a loss of time and self-consciousness. Indicative of focussed engagement was the active and willing participation by the learners in the activity. The learners clearly felt that they were in a practical, realistic and authentic setting, as opposed to a theoretical setting, and that they were a part of, and immersed in, the environment. The program's reality became the learners' reality thereby allowing the learners to feel personally connected to and owners of the decision-making process.

The students also showed evidence of engagement in the environment, particularly in the ethical issues. These were a factor which were the topic of much student discussion which carried over into their informal discussions after completing the
program and were mentioned frequently in their interviews. The ethical issues were the most frequently mentioned component of the program and proved to be one of the most thought provoking aspects. Environmental engagement was also evident because the learners displayed behaviours of feeling at one with and part of the activity. The learners were involved with and attentive to the activity and their attention was clearly captivated. Many physical signs such as pointing, reading aloud, discussing aloud and making calculations were all indicative of immersion and a deep and absorbing environmental involvement in what to the learners, was clearly a ‘real world setting’.

The students demonstrated several incidences of emotional engagement by imagining themselves in the program scenario and by displaying a wide range of emotional responses to the unfolding events within the program. Although most of the students stayed on task most of the time, there were fewer obvious incidences of cognitive engagement than focussed and environmental. Emotional engagement was clearly in place when the learners contributed to and personally experienced the events within the activity. Whilst the environment was clearly identified as, and understood to be, fictitious, expressions and displays of elation, disappointment or concern, expressions of expectations for success and fear of failure and indications of belonging and efficacy (as opposed to alienation) were all clear and constant indicators of immersion and engagement. It was evident from students’ responses that cognitive and emotional engagement are somewhat intertwined, with the reality of the program causing excitement and sometimes frustration when things did not go well.

Finally, as to cognitive engagement, generally with little or no distractions, the learners were clearly almost always engrossed in the program, on task and oblivious to distractions. The learners were clearly immersed and absorbed within the program.

The process of immersion appears to be tied up with a complex set of physical and emotional affordances of the environment which creates a compelling sense of “being there” (Psotka, 1995). The majority of students demonstrated immersion by controlling their attention and focusing on the scenarios to the exclusion of their surroundings, they also exhibited pleasure from the novelty of the experience and displayed a richer understanding of some of the issues of share investment, such as
insider trading. The findings in this section suggest that students valued the fact that the program was in the first-person and that they could readily identify with the authenticity of the situation and “willingly suspend disbelief” by being participants in the program, and by taking the content and the scenarios seriously.

**Reflection**

The second learner effect which the program was developed to generate was reflection. Reflection is a metacognitive strategy where the students think about how they are going to approach a task or a problem (Jonassen, Mayes, & McAleese, 1993) and students can demonstrate reflection by thinking where to go next, pondering their actions, solving problems and relating the feedback to their actions. There were three main behaviours observed from students which were indicative of reflection: dealing with conflicting advice, synthesising the feedback and putting theory into practice.

Students who demonstrate dealing with conflicting advice did so by synthesising information from a variety of different perspectives and sifting the relevant information from the irrelevant before applying the information to their problem solving.

Frequent feedback in the form of profits and losses, explanations by on-line characters and hints and tips was given by the program and formed the basis for students to reflect on their decisions and subsequently anticipate a chain of events.

Theory into practice describes the process of moving from acquiring new concepts to putting them into action in some way, reflecting on connections and relationships, and possibly applying them back to personal experience.

**Dealing with Conflicting advice**

Students could obtain their information through written material, phone calls and news and current affairs information on the television. A natural outcome of these multiple sources of information is that some of it is conflicting. Many students demonstrated reflection in dealing with this information to determine which they would act upon and which they would discard, and this came through strongly in their interviews:
You had to think when you were doing things, like the dividends only got paid once a year and that's the only cash flow you get and so you didn't really have to get into the formulas, and you couldn't use any other formulas, so you were just sort of speculating they've given you that information and you had to think, well shall we sell them or shall we not, or should we buy them, or if the price has increased or decreased we looked at that as well. Lion Oil was increasing and we could see that they were going to keep increasing so we bought more, but apart from the first time, we didn't really use perpetuities (Karen interview).

It was good to get all the information ... what happened this quarter, what happened that quarter, so the information was beneficial, sorting out what we needed to know, things like bosses dying and stuff, you needed to think about what happens with things like that. It's not up there in black and white, you still have to work out what you're doing (Mark interview).

You had to work out what to take into account when buying and selling shares. A lot of information's there and you've got to work out what's more important than others. I mean in other games we never had people die on us and not knowing what's happening. We tended to take into account specific information, more than the market stuff I suppose, the company's information rather than the world economics stuff (Simon interview).

Each of these students is talking about how they had to distil the relevant information from the irrelevant. Some of the information was embedded in the content of the program and some was contained in the feedback. None of these students was trying to find the perfect answer, instead they were concentrating on working out what was happening and thinking about what would be the best solution for them.

There was strong evidence that the conflicting advice was a source of reflection for many of the students. There was much talk about the implications of what they were told and when they were proven right, showed emotions ranging from smugness to elation. When they were proven to be wrong, they spent some time puzzling over the reasons, and even showed some distress at times.

For example, Mark and Simon had a long discussion about the price of the Castle Mining shares, where their valuation conflicted with the advice they were receiving in the broker's office. They eventually decided to trust their interpretation:

_I dunno. The broker reckons that Castle Mining is going to keep going up, but I reckon it's overvalued_ (Mark talk)

_I agree, I think we should sell_ (Simon talk).
The discussion shows that they recognised the conflicting information and dealt with it in a thoughtful way. Jean and Greg had a similar discussion on Austbank:

The price last quarter was $1.50 and they reckon it'll still go down more, but there are no indications in the market. It seems a pretty steady stock, and the company report confirms this. We've learnt that the bank will keep growing in the foreseeable future, I reckon we'll get a market return in spite of the contradictions (Greg talk).

and, in the next quarter when he was proven correct:
Hah! I knew I was right! Can't fool us, heh? (Greg talk)

....! I can't understand it. Castle Mining is overvalued to buggery and yet it's still going up. Why did we sell! Should have known! (Mark talk).

Greg has clearly identified what the conflicting advice is and has worked out how to deal with it. When he is proven to be right he shows elation. Mark, on the other hand, is upset because he did not deal with the conflicting advice well, making the wrong decision and therefore losing money.

Many students in their interviews, reiterated the confusion that the conflicting advice caused, but saw it as a device for deliberation rather than as an impediment to their progress:

We were told that interest rates might increase, so we'd have to increase the required rate of return and then we got the phone call and two conflicting bits of information so that really made you think about it (Karen interview).

It took me a while to work out which approach to take, obviously you have to investigate the company before you invest, so it was a question of after that what do I do. But it's ok, I found my way through (Marie interview).

The need to reflect was evident in these comments; conflicting advice caused the students to reflect on what they were doing, but also caused them to relate what they were reading and hearing back to their own experience of the world.

The levels of reflection varied between the pairs and singles. Analysis of the video tapes and interview responses revealed that the paired students appeared to experience reflective behaviour more than the single students. This is particularly apparent in the area of conflicting advice which none of the single students mentioned in their interviews. The paired students not only talked about the conflicting information in their interviews, but they were heard discussing it
extensively as they worked their way through the program. Reflection was aided by collaboration with partners, where the students provided each other with social support and shared expertise, but also each gave the other an impetus to self-reflection (von Wright, 1992).

Thinking about the different forms of information also encouraged planning and strategic thinking—these will be discussed in Research Question 3.

Synthesising Feedback

In spite of the fact that making money was not the primary goal of the program, all the students reported that they frequently used the monetary feedback as a basis for further investment decisions and promoted further consideration of their next investment decision. For example:

...I liked seeing how much money I made or lost—it made it like real life. It made me think about what I'd done wrong and what I had to do next time to fix it (Mark T interview).

This statement suggested that Mark T could relate the feedback to real life, whilst also reflecting on poor decision making. There were various forms of feedback; students had access to on-line characters one of whom invested using all the correct criterion, and the other used only his instincts. Students could compare their performance with these on-line characters. There was also on-line help in the form of hints which were available from each location in the environment, and coaching tips which were also freely available for the first three quarters. Students were also able to compare their investment decisions with market updates available in the broker's office. These multiple information sources continually provided contexts for reflective thinking.

There is evidence from the audio and video tapes that students who accessed these alternative forms of feedback compared them with their own performance and thought about the implications. An example is this conversation between Mick and Sharni:

OK, shall we check Sean and Wanda and see if they agree with us? (Mick talk)
Yeah, if you want (Sharni talk)
Oh look, Wanda is saying that Castle Mining are overvalued. Did we work out that they are overvalued? (Mick talk)
Um, we thought they were ok and bought 3,000 (Sharni talk)
Damn, what does the quarterly report say? Shall we go to the broker and look? (Mick talk)

I reckon we could lose a bit if they are overvalued. Maybe we'd better think about selling a few to spread the risk (Sharni talk)

If you look at this [the quarterly report], they're going up. Maybe that chick [Wanda] doesn't know what she's doing (Mick talk)

Yeah, maybe (laughs). So what do you want to do now? I reckon we should leave them for one more quarter and then think about selling. We've made some profit on them till now (Sharni talk).

Mick and Sharni are comparing their performance with that of Sean and Wanda (the on-line characters). By looking at Wanda's investments they were encouraged to reflect on their decisions, determine whether they were good or bad, and what they should do about it.

Feedback in the form of profits and losses on their investments were available in each quarter, and the students were frequently observed pondering the reasons for the variations in prices:

OK, let's check the prices and see how we've gone. Right we've made a profit on Austbank and Diversify, but look what's happened to DNA and Castle Mining. Why did we lose money on them? Oh, Castle Mining was overvalued by $3.00 and we didn't pick it up. Serves us right, investing without checking the valuation (Greg talk)

Yep, next time we use our heads, not get carried away with the flash company report (Jean talk).

I spent quite a bit of time comparing what I had done with various bits of advice available to me in the game. Sometimes I think I made better choices than Wanda (Jon interview).

Jean and Greg also used investment feedback to reflect on their decisions and actions. Having seen what happened to the investment prices and considered the reasons, they then made further decisions. Jon spent time comparing his decisions with feedback from the program and in some instances, felt that his were superior.

Mark and Simon felt the feedback being in the form of financial gain or loss was useful and appropriate, forcing them to reflect on what they had done:

Wicked, look at those profits, we've made 16 grand this quarter. Shall we go celebrate (laughs)? Mind you DNA went down, typical, typical, typical, why did it drop so much? [expletive deleted] Let's go back to the broker and see what he has to say about this (Simon talk).
They experienced the joy of making a profit and the dismay of making a loss, but were quite prepared to discover why a particular stock went down and to see what they should do about it.

Feedback was used extensively by both groups of students to reflect on their actions, evaluate their performance, and make further decisions.

**Putting Theory into practice**

When learners put theory into practice they are thinking about what they learned, reflect on previously acquired knowledge and determine implications of the information. This reflective thought is what helps the learners to make sense of what they know and experience (Jonassen, 1994).

The microworld provided the students with multiple representations of the information necessary to value shares. The students had the choice of working their way through the three tutorials, completing the examples, checking their answers and exiting the program. However, not one student elected to do this. Without exception, every student went to the “game” section of the program in order to apply this newly acquired information. In the game, the students applied the information gained in the tutorials and other content areas of the program to the buying and selling of shares. The advantages of the application of theory to practice was recognised by Sharni when she said:

> I'm not the type to learn from books. I never used to know anything about share markets, but now I know that the company will say how much they sell and things like that, how much the dividend pays, how much the interest rates are linked to the information that is given, so I know I've got an idea that this is the information that other people will look for if they have to go and invest in the markets (Sharni interview).

Sharni is saying that she found the theory difficult to absorb from a book, but having played the game, she can now see how all the different elements are interrelated and the importance of each, and, through reflection, is able to link the new knowledge to her existing conceptual framework.

Students thought about what they had read or heard prior to making their decisions, sometimes revisiting places to ensure that they had made the right decision.
You wanna check that stuff on present value again just to make sure? (Sharni talk)
Yup, don’t want to make the wrong decision (Mick talk)

These students were treating the money as their own and the investments as real, and did not want to risk a wrong decision (with the implications of losing money), so carefully checked the facts before finally committing themselves, trying to anticipate a chain of events and make corrections in advance of their actions. These self-correcting activities are part of the process of reflection.

The students did not appear to separate the content from the application of the content, instead they used the content to support their investment decisions and explain why they may have done badly, as exemplified by Greg:

Oh no, look we’ve lost a few grand on DNA. Now why is that.
Quick let’s get to the broker and check out the market reports (Greg talk).

Greg’s reaction to losing money on a stock was fairly typical of the group. He wanted to know and immediately set out to investigate. Apart from Karen and Bill, none of the students reflected on why a stock had done better than they expected, they just accepted their good fortune. The following comment is typical of this:

Wow! We’ve done well on Austbank. Great! But look at DNA.
[expletive deleted] what’s happened? We’d better see what’s happened, we may have to sell the rest (Mick talk).

Like Greg, Mick is wanting to know why DNA went down, but apart from pleasure at the fact that Austbank’s price improved, there was no reflection on the reasons for the increase in value.

Although none of the students exited the program immediately after completing the tutorials only, three of the single students completed the program without spending very much time in the tutorials. These students relied on the practice to provide them with much of the theoretical background, a fact reinforced by Mark T’s interview comment:

I found that I discovered the principles of investment from putting it into practice. I know all the stuff was there in the tutorials, but I wanted to actually do the investing so didn’t spend much time there. By actually investing and checking all the information I learned loads about the theory of investing (Mark T. interview).
Mick and Sharni had a similar experience, finding the tutorials too taxing to spend the bulk of their time using them and instead, finding out the necessary information from the alternate sources provided:

*Me and Sharni, we found the tutorials really hard work. We hadn’t learnt any of that stuff before and it would have taken us a long time to work through them, so we just went straight to the game and found all the information we needed in the library, the people, and the broker’s office. We still learnt a lot and it was more fun and it wasn’t as hard (Mick interview).*

Evidence from the interviews highlights the fact that of all the students, pairs and singles, Mick and Sharni spent the least amount of time on reflection. This could be ascribed to the fact that they found the content of the tutorials difficult and did not apply as much of the theory to their investing.

Although they tended to do it in different ways, the context of the program appeared to help the students apply the theory to practice, make decisions and solve problems, and consider the implications of their actions. These are all evidence of reflective activities.

**Summary**

A person is reflecting when he or she is thinking and analysing how a task or problem is to be approached and/or considering outcomes from previous activities. The program provided diverse feedback in the form of profit and loss forecasts, explanations by on-line characters and tips, and it also provided conflicting advice in the form of written and verbal materials including phone calls and TV news and current affairs information.

When the learners encountered this feedback and advice they all confronted the conflict, synthesised the information, discarded what they perceived to be erroneous or misleading, pondered their actions, solved (in theory) their problems, put their best possible solutions into practice and finally considered the fruits of their actions, and in so doing they had all proceeded through the reflection process. The conflicting advice experienced caused some of the students concern, but most of them dealt with it readily sometimes bringing their own experiences and prior knowledge to bear on their problem solving. This occasionally included conversations about what was happening in real world current affairs. The majority
of the students were able to synthesise relevant material, evaluate alternatives, and make decisions based on information made available to them.

All the learners indicated that the ability to apply, in the setting of a game, information gained in the tutorials and other content areas was a real and substantial advantage of the program. For the learners, the game (and its apparent reality) linked the different elements and gave them unity and meaning. When the game produced a share loss, reflection was, without exception, the consequence in that all the learners reflected or provided reasons that might either support their decisions or explain their losses. Interestingly, there was little reflection on why a share profit had been in excess of expectations. The game induced reflection because students needed to consider previous actions in planning subsequent moves.

Overall, it was apparent that the pairs spent more time on reflection than the singles. This appeared to be because they spent more time working through the tutorials than the students working alone. The pairs were also able to verbalise their thoughts, thereby giving a means to measure reflection, whereas the single students could have reflection measured only from their behaviour and interviews.

The findings suggest that the students reflected by evaluating and re-evaluating information in the light of feedback received. New knowledge was integrated into students' existing conceptual framework by being linked to existing knowledge rather than being learned in isolation, and feedback was used to think about their performance, particularly when they make the incorrect decision.

**Flow/Play**

The development of a sense of flow/play was another learner effect deemed critical for creating engaged and motivated learners. Flow has been defined as "an holistic sensation where one acts with total involvement, with a narrowing of focus of attention" (Novak & Hoffman, 1997b, p2). The flow state is one where those in it feel detached from the world and people in a flow state are totally focussed and engaged in what they are doing (Skelly, 1995). Flow is used in this context to describe the time spent being unaware of surroundings or the passage of time. It parallels with immersion in some respects as in order to experience a "flow state" (Csikszentmihalyi, 1992), students have to be completely absorbed in the task,
unaware of surroundings and distractions. In such instances students should not feel anxiety, boredom, instead experiencing enjoyment, novelty and a sense of "play".

In the context of this program, play is possible through using the "what if" scenarios in the content which can be undertaken without the implications of failure and every expectation of success. Such flow experiences are likely to leads to intrinsic enjoyment and loss of self-consciousness; in such instances when the activity includes the "seamless sequence of responses facilitated by interactivity with the computer and self-reinforcement" (Hoffman & Novak, 1995); and the pre-conditions are skill/challenge balance and focussed attention (Csikszentmihalyi, 1990).

The existence of flow was evidenced in the study by three behaviours among students: Loss of self-consciousness, Enjoyment and Protracted engagement.

**Loss of self-consciousness**

Students who are in a flow state experience a loss of consciousness of self, time and space. There were many instances of students being in a state of unself-consciousness. Typically these were demonstrated by students being generally unaware of what was happening around them for large periods of time as the following extracts show:

> I wasn’t aware of what was going on, the camera didn’t worry me, the sound when you click from one warp to another caught me out, strange sound anyway (Ted interview).

> We were fully immersed in the system. We enjoyed it, buried (Sharni interview).

> I was unaware of events happening around me, completely absorbed (Jon interview).

> Even when the computer crashed, I was still able to think about my next strategy, I wasn’t put off (Marie interview).

These examples all suggest that the learners displayed little consciousness of what was going on around them, instead displaying a detachment from the reality of their surroundings and a complete absorption with the program and its goals. Marie’s comments exemplify this when she talks about the computer crashing which would normally interrupt the flow state. Instead, she continues to work on her strategy and refused to be put off.

Several students mentioned a lack of awareness of time passing as exemplified by the following:
We were pretty good. It was an hour and a half and we weren't bored, we didn't notice the time. (Mark interview)

Oh my God is that the time? I told my father to come and pick me up at 3.30, I thought I would have had enough by then. I'd better ring him (Jean talk).

Yeah time flies when you're having fun, I haven't even thought to look at my watch (Greg talk).

This lack of awareness of time shown by students above is a classic example of being in a state of flow, where time changes, slows and becomes different (Skelly, 1995). Lack of boredom and increased fun seem to be contributing factors to these students being unaware of the time. These examples all suggest that the students' attention was so focussed on the activity that irrelevant thoughts were filtered out.

Review of the interviews and videotapes highlight the fact that both groups of students, the dyads and the singles, exhibited a loss of self-consciousness and time at various stages of the program, thereby experiencing a state of flow.

**Enjoyment**

Another indicator of flow and play is intrinsic enjoyment. (Csikszentmihalyi, 1990). The students found that they derived enjoyment from the humorous elements incorporated into the program:

*I found this very enjoyable. The ones [programs] I've used in the past have been very stringent, you're told what to do, and then kick out of that and then do a spreadsheet or a task. This was more enjoyable the way it was set up, it was more interactive, you were given more freedom to go where you like and when you like and I just found some of the things that were put in there like the tv screen, the phones ringing and the fact that you could go where you liked, I found those things quite amusing* (Jon interview)

*The little props, phone, tv, the fact that you get to check your share prices and portfolio, that's all good fun* (Greg interview)

*I think it was the little things like the tv and telephone, a combination of a bit of fun and a bit of thinking* (Jean interview)

*It was quite funny, humour is an excellent learning tool* (Bill interview)

*Telephone was the best thing. We were having fun. Not only did we learn, but you made it simple and exciting* (Simon interview).

In all these examples the students exhibit evidence of intrinsic enjoyment. This in itself is perhaps not enough to infer that the students were in a flow state, but when
coupled with the earlier statements regarding lack of awareness of time and surroundings, it appears that these students exhibited a number of the characteristics of a flow state.

Many of the students were observed to experience some of the effects of flow to some degree because their interviews confirmed that they enjoyed the characters, the “props”, the humorous comments on the tv, and the random elements which were incorporated. This enjoyment and novelty helped contribute to their loss of self-consciousness as they became immersed in the characters and the “scenery” of the microworld they tended not to notice their physical surroundings or the passing time.

Flow is also difficult to isolate from some of the other learner effects identified for motivation and engagement, namely; curiosity, learner control, and challenge. A number of researchers have identified these elements as being essential to the flow state (cf. Clarke & Haworth, 1994; Csikszentmihalyi & LeFevre, 1989; Trevino & Webster, 1992; Webster, Trevino, & Ryan, 1993), however these behaviours will be discussed later in this chapter.

Another facet of enjoyment of a computer learning environment is the ease of interactivity. Seamless interactivity is an important component for the flow experience. Students who are experiencing seamless interactivity don’t have to think about the construction of the computer program, instead finding their way round it intuitively. This mapping (the naturalness of the interaction) leads to play and the exploratory behaviour is an outcome of flow (Novak & Hoffman, 1997a).

Exploration and mapping helped the students to construct mental models of the program elements. The following interview quotes show some examples of mental model construction for some of the students:

...just going into rooms to have a look, because you could always come out of them again, it’s not like you go in them, you’ve got to do something, you can explore a bit. The graphics are very good—you go through a door—very logical. You go into the gallery and the stock exchange, that’s very logical so you had a graphical fix rather than just trying to click on some disembodied button or something, at least you imagined yourself in the stock exchange or imagined yourself in the broker’s office (Bill interview).

...because we don’t have to look for work names and things like that, you can just click on a location and the information is there. It was
very intuitive, I felt like I was moving around learning about how the stock market worked and was laid out (Sharni interview).

I liked the fact that you didn’t have to drill through things to get the information like on the internet. I could move around easily by clicking on the map or on a door and boom! I’d be in there. (Mark T interview).

This “graphical fix” from the structure of the program aided these students’ mental mapping of the content, the fact that they could click on a door to enter a room aided them in imagining themselves in the environment. The seamlessness of the environment was a contributing factor to this mental mapping and when Sharni felt that she was learning how the stock market worked, her attention was fixed on the activity, meaning she was in a flow state, eliminating all outside influences.

Bill, Sharni and Mark T were all describing incidences of exploration, where they moved around in the program, experiencing the various areas and were able to picture themselves in the environment. Bill’s comment about the “disembodied button” illustrated the fact that in the past, much educational multimedia used decontextualised icons to move the students through the program which interrupted the flow state as students tried to work out their functions. Observations of students using this program showed that an ecological interface which gave a mimetic representation of a real-life environment enabled them to identify with the context of the program and intuitively move through it. These observations were reinforced by the comments made by Bill, Sharni and Mark T and were elaborated on by Jon and Marie:

I found I could identify with where I was and what I was doing. I enjoyed clicking on the various areas and seeing what they did, and could instantly work out where to go (Jon interview).

I really enjoyed finding my way around. I really had to think about all the different areas and what I had to do, but once I started, I just did it and forgot about everything else I had going on (Marie interview).

Both of these students experienced a sense of personal efficacy and were engaged in what they were doing. Marie obviously felt detached from the world and was totally focussed and enjoyed what she was doing.

There did not seem to be any great difference between the paired students and the single students in terms of the enjoyment of the program. The paired students
tended to laugh out loud more often and discuss things which amused them, but the single students were observed to smile and several times there was laughter recorded on the audio tapes of these students. Interview comments also highlight the fact that the students working alone found the experience to be enjoyable and fun.

From observing the students and interpreting their talk, it appeared that many of them found that it was the structural properties of the program that contributed to their flow state, with the seamless sequence of activities and intuitive interactivity. Several of the students also exhibited incidences of telepresence—an antecedent of flow—where they imagined themselves actually in the environment, experiencing its effects, identifying with the content and exploring the environment.

**Protracted Engagement**

Protracted engagement refers to student activity where students are absorbed in the one task or activity for a prolonged period of time with a narrowing focus of attention.

Several incidences of long engaged conversations were observed indicating a flow state; the fact that some students reported that they were unaware of the passage of time for long periods, and that there were no reported incidences of boredom or anxiety over two hour periods. These behaviours tended to occur at times throughout the program and did not appear to be related to particular tasks or activities. For example, Karen and Bill had long discourses on calculating the formulae and then about how they should invest, Mark and Simon spoke at length about the implications of their investments, and Greg and Jean spent a long time talking about the application of some of the concepts.

The paired students as a group spent the major part of their time in areas such as Tutorial 1 and 2 and the library, and the single students spent the bulk of their time in the office, the buy/sell screen and the broker. These extended periods of time are indicative of students experiencing equal challenge and skill levels where students are on-task for lengthy periods of time. These differences could be caused by the nature of the multiple representations of content, and the differences in the interaction styles between students collaborating and those working alone. The pairs, because they could talk ideas through with each other, may have been much happier to work their way through the heavier content areas of the tutorials and then
transfer that learning to the investments. The singles, on the other hand, having no-one to interact with, may have found the alternative representations of the theory in the broker's office, the viewing room and their office, to be easier to interpret and apply. The fact that there were repeated examples of the students spending substantial periods of time in various areas, and video tapes showing them pointing at the screen, writing down information and calculating formulae and moving between the various information sources and the buy/sell screen, infers that they experienced periods of flow at least for part of the time.

One of the prerequisite states for a flow experience is that the challenge and skills are above a certain level and are in balance (Csikszentmihalyi & LeFevre, 1989). Although discussed later in this chapter, it is useful to note here that all the students except Mick and Sharni coped well with the challenge. Several students even alluded to this fact in their interviews:

I felt pushed, but not excessively (Ted interview)

I thought the degree of difficulty was just right - we felt stretched, but we still thought we were capable of mastering the stuff in the program, we actually got a thrill when we worked out a formula correctly (Jean interview)

I didn't feel like I was struggling with the material, I felt more like I was playing a game and learning at the same time, so I guess I would say that the difficulty levels were pretty good. I don't know how I would have felt if I was doing this on my own in Widjimoutha though (Bill interview)

We found it quite difficult, I enjoyed playing the game, but found the formulas hard to work out. But, we did make money and as I said before, we didn't learn anything, but we worked out where to go and get the information so we could make our decisions (Sharni interview).

From these comments it is clear that these students felt challenged, but not excessively so. Bill mentioned several times that he might have trouble if he were an external student without peer or lecturer support. Although Mick and Sharni felt that the program was too difficult for them (they completed the pilot study and subsequently many modifications were made as a result of their difficulties), they did exhibit elements of learner control and maintained a strong sense of focus in the program. These are both important elements for achieving a state of flow (Webster et al., 1993).
There were a few differences between the ways the paired students and the single students used the program. For example, the pairs spent the bulk of their time absorbed in tutorials 1 and 2, the library and, to a lesser extent, in the broker, whereas the singles spent the bulk of their time in the office, the buy sell screen and the broker. These differences will be explored in greater depth in Research Question 2.

The flow experience was not limited to any particular part of the program—instead observations showed students tended to experience it on and off all the way through. The single students and Simon and Mark experienced the least flow in the tutorials, but were all deeply absorbed by the information contained in the broker's office, discussing the problems and the information. An explanation for this could be that the stimulus was presented in a way more appropriate for students working alone, and therefore captured their attention causing them to attend to it in a focussed way.

Summary

If one is totally involved, focussed and engaged, unaware of surroundings, distractions or the passage of time, then one is immersed within a state of flow.

The learners for long periods of time displayed little or no consciousness of their surroundings and they were completely absorbed within the program and its goals. The learners were unaware of time, they were not anxious, distracted or bored but rather they were focussed, experiencing excitement, enjoyment and interest (through what they perceived to be the program’s inherent freedom, intuitiveness, seamless interactivity, fun, humour and novelty) and in this mode the learners were in a state of flow and play. Generally the learners felt that the perceived challenges created by the program were in reasonable harmony with the acquired skill base and the successful balancing of the two is viewed as critical in the flow experience.

At various times all of the students were observed engaging in sustained interaction with the program; forgetting about time and place; finding the program enjoyable and fun to use; and finding the interactions seamless and intuitive. Evidence of students working demonstrated behaviours where the program induced flow by absorbing students in the “script” of the environment where they experienced
curiosity, control and challenge, all of which are consequences of flow (Novak & Hoffman, 1997b).

The paired students and the single students all exhibited a sense of flow at times during the program, and demonstrated the flow behaviours—of intrinsic enjoyment and loss of self-consciousness—in different areas of the program. The majority of the students also demonstrated the antecedents of flow—skill/challenge balance, focussed attention and telepresence.

Apart from Mick and Sharni, all the students responded well to the blend of challenge and skill, with a word of caution issued by Bill regarding students working on their own at a distance may have some difficulties with some aspects of the program. A future study will investigate how students working in isolation use the program.

The program was designed to sustain flow by providing students with the opportunity to "play" in an environment to which they could relate completely and which attempted to eliminate feelings of anxiety, boredom and frustration, replacing them with expectations of success by balancing the challenge/skill levels and providing a seamless integration of elements which would not impinge on the students' sub-conscious mind. In this way it was quite successful.

**Collaboration**

Another learner effects considered central to motivation and engagement was that of collaboration. Collaboration involves a large amount of discourse, where learners are able to share their knowledge (and often, lack of knowledge) with each other. The social aspects of collaboration are important for motivation as evidenced by the work of (Vygotsky, 1978). Examples of collaboration include reading aloud to each other, planning, developing strategies, sharing information, coaching, making suggestions, explaining and questioning, awareness and acknowledgment of the other's prior knowledge, and discussion about what is happening.

Learners working collaboratively together show incidences of reciprocity, where they share the discussion on the segment they are trying to understand. Collaborative learners may organise their talk around four main comprehension-monitoring activities: questioning, summarising, predicting and clarifying (Campione, 1996). These activities involve probing each other's knowledge, planning
and strategic activity, goal sharing and engaging in effortful discourse about the content matter.

Researchers in this area have found that students working in dyads outperform those working alone (e.g., Dalton, Hannafin, & Hooper, 1989), and that there are higher level elaborations, such as explaining, between the students which may lead to greater learning gains (Carrier & Sales, 1987).

The students who collaborated all worked well together, talking each other through the formulae, sharing the calculator, reading aloud to each other. They also talked to each other about where to go next and how to navigate through the program. Although there were many incidences of the four comprehension-monitoring activities as outlined above, the students illustrated various degrees of scaffolding and coaching each other and felt that this was one of the main benefits of working with a partner. This attitude was exemplified by Jean in her interview:

> The best part was having Greg there—he coached me sometimes, I coached him sometimes, we gave each other support and help, until we'd got the idea and then we moved on. I wish we could do that in lectures (Jean interview).

This attitude was verbalised by all the collaborating pairs to some degree.

**Scaffolding and coaching**

Working collaboratively is an essentially social activity, and the students scaffolded each other by joint problem-solving as they worked their way through the program trying to attain the perceived goals.

Evidence of collaboration included students who shared their views of the situation, helping one another understand the meaning of the material, for example:

> I think we should sell DNA now (Sharni talk)
> Why? (Mick talk)
> I reckon they're going to go down, it says here that at best they're speculative, I think we could make more money in one of the other shares (Sharni talk).

Here Mick was questioning Sharni and she summarised her reasons for her decision, thereby helping Mick to understand some of the process of decision-making in this instance.
Karen and Bill had long discussions where they stimulated each other working through the formulae, with Karen often providing the coaching necessary:

Well let's say just look at this one here (Bill)
It was $5 which is the 5 (Kelly)
Well that has to be the present value (Bill)
and the $11 is the future value, 6 is N and we don't know why so we've got to work out I, which is 14.04% (Kelly)
Yes, yes, it's rather interesting that they say $5, 6 years ago and then use it as present value (Bill)
Yeah, you've got to remember because present value is when you started (Kelly)
Is before? (Bill)
Present value is not now (Kelly).

Rather than just learning cooperatively, Karen and Bill were questioning and clarifying, each helping the other to understand the information, all of which are redolent of collaboration.

The four pairs frequently checked their partners for understanding and at various times even tested the other's knowledge, for example:

You determine the present value of the 50 cents in year one, the present value of 50 cents in year two, oh hang on a second, maybe that (laughs), maybe that 2, 3, 4 is the year (Bill talk)
Yeah, but it doesn't look right. If you have a dividend it doesn't equal $2.89 because $4.50 divided by 1.244 is $3.62 (Karen talk)
That's right isn't it? Right well just prove it again. OK so we'll just do it Dick and Dora style cos those will be exactly the same, just year 1, year 2, year 3, year 4, so (Bill talk)
Well, no they wouldn't be the same, cos you gotta bring them back further (Karen talk)
Oh yes of course, you're right, it the power of 2, the power of 3, the power of 4. Well done (Bill talk)

...we just shared the opinion like how we handled buying and selling shares and things like that. We learned a little bit, and he and me we just talked, our knowledge was different, I was picking his knowledge, he learned a different bit of finance and I learned a different bit, even though we have the same lecturer and go to the same lectures. I was telling him stuff, teaching him things, but when we got into the hard part, the learning sessions, I didn't understand it, so I said OK I don't want to do that, so after that we didn't learn any new things, we learnt the things we'd already learned. Very good for sharing the knowledge we'd already got, good for reinforcing (Sharni interview).

It's probably just the way the whole program operates. It would be kind of boring by yourself, you'd just be sitting there. It's nice to have a bit of conflict to help you through it. If you don't know something, very often the partner will, and vice versa. You can ask
them what does this mean? What do you think? Group decisions are good, helping each other (Mark interview).

This exchange of knowledge and ideas occurred throughout the program, in the tutorials and in the investment component to varying degrees. Although once they began investing, they discussed where to go next and what to buy, some of the students continued to coach each other where necessary, they also planned their actions together, as shown by the following example:

Let's go to reception. OK, cool. Now where are we gonna go, stock exchange, library, broker? (Simon talk)
We'll go to the stock exchange and look at what we've got first off and then we need to start looking at what shares are worth what before we start buying (Mark talk)
Yeh, 'cos we don't own anything at the moment do we? (Simon talk)

The nature of Mark and Simon's talk here was clarifying what to do next. Occasionally it was noticed that a few of the students were modeling their responses on information provided by the microworld without realising it:

We didn't apply any theory to the investing. What we did was go to the broker's office or his area and just looked at the information such as price and how much the dividends were, the selling price and how much the markets were varying, and also the advice of brokers saying buy the shares, and things like that. So we wrote everything down made comments on it and then we went to the actual market and we bought the shares and then warped to check our progress (Sharni interview).

This is an example of students collaborating with the microworld rather than relying solely on each other, summarising the information provided and synthesising it so that they could then predict what their next action should be. Sharni's comment is also a classic example of a student reflecting on the goal-action-feedback cycle which is usually missing in media based learning (Laurillard, 1993).

Students working alone were limited to their own resources and those of the program. They were denied alternative explanations and perspectives which might have produced cognitive dissonance or supported the strategic planning process or the acquisition of knowledge (Dalton et al., 1989). Therefore, students working alone tended to collaborate with the program much more than those working in pairs. The following table highlights this trend:
As evidenced from Table 7.3, the single students accessed the hints section for a total of 12 minutes compared with a total of one minute for the pairs, three of whom did not access them at all. As stated earlier, the pairs coached each other through the program, whereas the singles, lacking this type of collaboration, appeared to turn to the program to provide the help. The same trend is seen with Sean and Wanda. The singles used them for a total of 15 minutes, presumably to provide feedback and advice, contrasted with the pairs who accessed Sean and Wanda for a total of seven minutes. Browsing was also used differently by the pairs and the singles, nine minutes for the singles compared to five minutes for the pairs. It appeared that the singles browsed to orient themselves to the program, whereas the pairs tended to talk about where to go and what happened in the various areas and therefore needed to browse less.

**Summary**

Collaboration involves the sharing of knowledge through discourse, discussion and joint planning.

The learners who worked in pairs collaborated in many instances through a process of joint problem solving and/or coaching. The results of the study showed that throughout the project the paired couples constantly questioned each other’s reasoning, they provided summaries or clarifications of their decisions, they questioned and tested each other’s knowledge (most of which was obtained, almost without realisation, from within the program itself), they planned and developed
strategic activity, and they discussed, at length, formulae and calculations; all of which were clear indicators of the collaborative process in full and effective operation.

The single learners, of necessity, were forced to collaborate to a far greater extent with the program itself through the more extensive use of built-in mechanisms such as hints and browsing. For them the scaffolding aspects of the program were their only fall back position—they did not have the advantage of a second view or a process of discussion. The fact that they did use the assistance of the on-line help and cues demonstrates both the need and value of a collaborative opportunity in use of the program. These factors provided evidence of the ability of the program to generate and support this attribute in the learning environment.

**Learner Control**

Another learner effect that it was deemed important that the program could promote was that of learner control. Learner control in educational multimedia allows the learner to choose freely the pace, path, content and feedback method. Adults tend to want to be more independent and exercise control of their learning, but many multimedia programs take a pedagogical approach where learners are treated as dependent. Learner control is considered to be different from browsing which is randomly looking through the program to see what’s available and to note the structure for future reference.

Students who exhibited signs of control chose their own paths through the program, enabling them to move at their own pace, and view the material which suited their needs. Instances of learner control were identified when students purposefully chose to enrol in tutorials or move to specific areas of the program in order to carry out a task, rather than looking at an area and then moving on.

There is a concern among educators (eg Kinzie, 1990) that learners may not be capable of exercising control in a flexible learning system, nor would they be motivated enough to really explore a program. Ted alluded to this in his interview stating:

Yes I like it, good, but you need to be self-motivated to get a lot out of it. Really need to know what you want to get from the program. If it told you where you had to go next it would take away a lot of the uniqueness of it, it wasn’t just a tutorial telling you what to do.
next, what to do now, because that's much the same as a lecture. Just go from here to there.

While Ted acknowledged the difficulties of self-setting goals, he also accepted the fact that one of the strengths of the program was that it didn't specify what the students had to do and in what order. It was not possible to find a student who exhibited difficulty in setting their own goals and exploring the program to achieve them, as the following comments suggests:

OK, so we know what we want to do, where do we go to do it? (Simon talk)
Dunno, let's go look. You happy with all the info we've got? (Mark talk)
Yep, we can go anywhere we want to I guess (Simon talk)

In a lecture the information is just put to you and that's the information you learn. I guess that's what I noticed when you went in. It didn't say "to complete this program, you have to..." it didn't have that so we could do what we liked in any order. We definitely did have control over what we were learning (Jean interview).

In a lecture you get told once and can't ask to go over it again, whereas with this sort of thing you can go back and make sure you've got the concepts understood before you progress. I think it was more fun not being told where to go all the time (Jon interview).

If I was told where you had to go next it would take away a lot of the uniqueness of it. It wasn't just a tutorial telling you what to do next, what to do now, because that's much the same as a lecture, just go from here to there (Ted interview).

It was a lot more fun than the lectures, the fact that I was in control, I could look around at things, go back to things, look to see what things did. It was more interesting, more satisfying (Marie interview).

The immediate comparison of the program with lectures by some of the students was interesting. This was most prevalent in the positive comments on learner control and appears to be perceived by the students as the biggest difference between the two modes of instruction. Several of the students raised the fact that they had the control and that they felt very positive about this. Marie's comment in her interview also highlights the interconnection between learner control, curiosity and flow.
Control of Pace

An antecedent of learner control is the ability to control pace. Many students found they were able to control the pace at which they worked and that this enhanced their efficacy with the program. Marie’s reaction was typical of several of the students:

*I had no trouble with this [program], because I could move through it as fast or as slow as I wanted. I could spent time with the bits I needed to and skim over bits I knew* (Marie interview).

Marie found that because she worked alone she could choose her own pace, but there were many examples of the collaborating pairs checking with each other to ensure that the pace was optimal:

*Am I going too fast? Tell me if I’m going too fast.* (Karen talk)

The pace of students varied considerably. Some spent longer in the tutorials and were then able to make their investment decisions quite quickly; others spent little time in the tutorials but spent much longer in other parts of the program trying to value the shares and validate their decisions (for a fuller discussion on this, see Research Question 2).

Interviews with the students shows that the ability to control their pace was an important aspect of the program for many of them:

*I think if I apply this program to finance lecture, some people feel a bit bored by the lecturer sometimes it’s too much to concentrate in the lecture for two hours with a lot of things going on, but the program itself you can work at your own pace, will help you to work out things, solving problems, it’ll be a lot easier* (Mick interview).

*I could go back to anything I might want to go over again, or skip over things I already knew, it was great* (Jon interview).

*I liked being able to take my time. I didn’t feel hurried by other students or the lecturer. I could really concentrate on the things I didn’t know* (Ted interview).

It is clear from these comments that the students felt positive about the ability to control their own pace and the fact that they had the ability to concentrate on elements about which they weren’t confident.

Mick however, noted that in order to utilise learner control, learners must be able to self-regulate their learning:
People must have control of themselves. Sometimes you work at your own pace, sometimes you take too long and some people are really keen about it, so working at your own pace there must be some control over the thing to give them enough time to do it on their own, but also pushing them to get their work done. Some people leave it till the last minute and then find they’re rushing. I think the program let me choose my own pace, but somehow encouraged me to keep moving to finish, I don’t know how, but I wanted to see how I was going (Mick interview).

Mick obviously found that there was enough intrinsic interest in the program for him to want to keep going and finish the program even though there was no compulsion upon him to do so. This encouragement could have been provided by some of the other learner effects built in to the program which exerted some pull over Mick without him realising it.

Pace is an important aspect of using a multimedia program, most of the students commented that they did not feel hurried, nor did they find that the program held them up in some way, moving them through it too slowly.

Control of Time

Time is another facet of control, where learners can elect how long they stay in a program or in any particular elements of a program.

Interestingly and perhaps surprisingly, the time spent in the program was not significantly different between the pairs and the singles, although no optimum time was specified and students could choose how long they spent completing the program. Table 7.4 below shows the total time spent using the program for each student or pair of students:

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simon &amp; Mark</td>
<td>101</td>
</tr>
<tr>
<td>Karen &amp; Bill</td>
<td>103</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>112</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>92</td>
</tr>
<tr>
<td>Marie</td>
<td>84</td>
</tr>
<tr>
<td>Jon</td>
<td>97</td>
</tr>
<tr>
<td>Mark T</td>
<td>82</td>
</tr>
<tr>
<td>Ted</td>
<td>93</td>
</tr>
</tbody>
</table>

Table 7.4. Total time spent in the program by each student or student pair.
This shows that the program had sufficient multiplicity of choice to engage students working alone almost as much as the students collaborating. Table 7.4 highlights the fact that the time difference between the students who stayed in the program the longest and the student who stayed in the shortest was thirty minutes. All other students fell within this margin. It is clear, however, that the collaborating students spent longer using the program and this could have been caused by the social-dialogical nature of sharing the learning (Duffy & Cunningham, 1996).

Only two students specifically referred to control of time in their interviews:

I liked the fact that I could control lots of aspects—where I could go, how long I could spend anywhere (Marie interview).

It was great, I could really take my time with the tough stuff. I didn’t feel rushed or hurried and knew that there was no-one watching how slow I was (Ted interview).

Control of time is an important aspect of learner control. Although only two students mentioned it, the lack of negative comments about time (eg being rushed, not having enough time to complete the tasks, etc) could mean that many of the students did not feel any time constraints.

Control of Process

When learners are able to control the process by which they use a program that simulates a real environment, they are able to get a better understanding of that environment.

A review of student talk and interviews showed that some students found they had to learn the established customs and conventions of the stock market environment, and the process by which those customs and conventions were determined was important in terms of the students' overall understanding.

So resources are resources like... and Lion Oil might be a goody (Bill talk)
Yep, yeah see these are all... Hey, not it's gone up, it's gone down, its Q. What is Q? (Karen talk)
Wait a minute, we're looking at it backwards, are we? (Bill talk)
Yeah, are we or are we not? (Karen talk)
Well that present, is that present? Yeah (Bill talk)
I don't know. What does Q mean? (Karen talk)
Quarter (Bill talk)
Quarter of equals? (Karen talk)
Quarter 1 less 1 quarter, less 2 quarter, less 3 and so on, so maybe 6 quarters ago (Bill talk)
Is that how information is always presented? (Karen talk)
I guess so, terrible admission but I don’t know that I’ve ever looked at any of this stuff for real (Bill talk)

In this extract Karen and Bill discovered that a stock market convention is the use of “Q” for “quarter” and that historical data is presented as “Q-1”, “Q-2”. This is an important revelation for anyone who wants to understand how the real stock market environment works and who might want to look at a past trend.

Marie found that initially she wasn’t particularly comfortable with the level of control she had, but eventually realised that it was important that she was the one making the decisions and ultimately preferred the level of control she was given.

At first I wanted the program to guide me more, but then I realised that if you are an investor it’s all to your discretion how you want to go about things. Personally I like to feel more in control rather than the program being in control (Marie interview).

This feeling was similar to one several other students had experienced and seemed to be an important discovery for the students. This lack of comfort initially with the degree of learner control afforded by the program may have been caused by the lack of control learners usually experience in a lecture, and students, therefore, may have been unfamiliar with the concept.

Handling Multiple perspectives

Learner control means that students are capable of making their own choice from a number of alternatives giving different perspectives on a particular problem. Multiple perspectives has been defined as an important cognitive activity that should be promoted in the design of interactive multimedia learning environments (Honebein, Duffy, & Fishman, 1991) in order for students to make content choices based on their own needs (Milheim & Martin, 1991). The use of multiple perspectives also provides learners with a much more complete learning environment that matches more closely what they will experience in the real world, thus allowing them to see the relevance of the material.

In the program under study learners had several choices of information: company reports, broker’s reports, quarterly reports, news broadcasts, economic updates, sharemarket analysts updates, as well as on-line characters (Sean and Wanda) and
the telephone. It was not possible to find a student who did not claim that this gave a
good mix of visual, auditory and printed material for them to choose from, and it
also gave them the opportunity to construct multiple perspectives on some of the
issues and problems, allowing them to see alternative viewpoints and choose the
best possible solution. The following examples typify student responses to the use of
multiple perspectives:

We can now see that there are other places to get information about
shares, other than the paper, and that only reports on the big ones
anyway which gives you trends, but you don't hear about small
ones. That's what's good, finding out about individual reports on
companies which you don't generally think about getting (Mark
interview).

We looked at a lot of the reports, we looked at them more and decided
what shares we'd buy rather than looking at the share prices now.
We relied more on information we found in the economy and the
market. There were some warnings which were very good, like the
discounted cash flow calculation for share prices is not what's used
by shareholders. You tend to look for capital gains rather than a cash
flow situation (Bill interview).

Mark discovered that the newspaper was not the only place to find information, and
gained a more complete understanding of the many sources of information
regarding companies and their shares. Bill covered a number of sources of
information in his interview statement and summarised which ones he used.

It was clear from the students' talk that the multiple perspectives helped many of the
students to understand each other's point of view. An extract from Mark and
Simon's talk was one such example:

I see, we've got all these different places we can get the information.
What do you want to check out first, the library, the broker or the
stock exchange? (Simon talk)

Yeah, well I reckon that Castle Mining is overvalued so why don't
we check out what the broker has to say about that, and then maybe
look at the quarterly reports to see if there's some sort of a trend?
(Mark talk)

I reckon that Com Corp looks like a better bet, why don't we check
out what's said about that one, first (Simon talk).

Simon and Mark discussed the various places they could go to get the information
they needed, and narrowed it down to looking for specific information. This is a
good example of how many of the students used the information choices.
Summary

If a multimedia program embraces in depth a truly flexible learning system as opposed to taking a pedagogical approach, then the program promotes what is known as learner control.

A repeated theme was noted of students wanting to move through the program at their own pace, unhurried by peers or lecturers. Self-regulation was mentioned several times by the students as being an issue that they were not terribly comfortable with initially, however, there were many examples that the ability to control aspects of their own learning seemed to be a critical component for students, and they linked it closely with their feelings of achievement and motivation. A reasonably high level of autonomy was welcomed by the students although it took them a short time to get used to the concept as it was foreign to their experiences in lectures.

Observation of the students showed that they moved around the environment freely, moving backwards and forwards in the content areas to glean as much information as possible prior to investing. The students were able to switch between the different areas to check information as they were making decisions and calculating formulae. This degree of learner control increased the flexibility with which they accessed information and certainly helped with their problem solving and decision making. This was particularly obvious with the students working alone as they lacked the ability to talk through their problems and decisions.

An important finding in this study was the need to allow students to have control of their learning. When the students feel in control, they fully immerse themselves in the narrative. This is the key to the learner investing effort in the mastery of the program (Leyland, 1996). This view is reinforced by (Csikszentmihalyi, 1990) who claims that when “we feel in control of our actions, masters of our own fate...we feel a sense of exhilaration, a deep sense of enjoyment” (p. 3). Hence learner control is an important ingredient in designing a motivating learning environment and is also tied closely to other aspects of motivation, such as flow.

The learners in the program all chose their own paths, moved at their own pace, explored the program and viewed the materials which suited their particular needs.
or requirements and by so doing, the learners felt that they were, in a positive and satisfied way, "in control".

Many of the learners clearly felt that the efficacy of the program was enhanced by not only their ability to control the pace and direction of their use of the program, but also the availability of multiple perspectives within the program which allowed free access to several forms of information. The ability to control the time spent within various activities in the program was also seen, by some learners, as a positive aspect of the program.

**Curiosity**

Curiosity was considered to be an important learner effect as it would attract students to the various elements within the program. Curiosity incorporates concepts such as novelty, complexity and the element of surprise. Curiosity may be denoted by "what-if" activities or by sensory inquiry where learners are attracted by changes in the sensory stimuli of an environment (Malone, 1981a).

There were a number of learner behaviours observed that were indicative of curiosity. Students exhibited curiosity when they explored unknown components of the program to discover extra features, and when they made speculative share transactions and looked to see the results. Likewise they exhibited curiosity when they followed information trails purely on speculative grounds to see where they led. These "what-if" types of behaviours were evident in many parts of the program, rather than being confined to one area. Other behaviours demonstrative of curiosity included sensory inquiry where students attended to and explored visual aspects of the interface.

**What-If Activities**

Students using the program demonstrated "what-if" types of curiosity in many different places and in many different ways. A typical example of this type of behaviour is demonstrated here in the activity of Jean and Greg:

*What do you think would happen if we bought another 3,000 shares in DNA? I know they're spec shares, but judging by the valuation they've got a bit of fat in them (Jean talk)*

*I agree, why don't we try them and see what happens? If we lose money on them next quarter, we can reassess things (Greg talk)*
Jean and Greg displayed curiosity when they discussed this scenario. Not only did their talk involve a degree of complexity, but there was also a level of discrepancy between the price of the shares and their valuation. This set up a level of inquiry where the students were willing to take a risk to see what would happen.

This form of prediction and planning was frequently observed among students in different stages of the program. For example, from Karen and Bill when they were looking to select shares:

.RIGHT, I think we should give Castle Mining a go. They are overvalued and we've held off investing. Let's try for one quarter and see how we go (Karen talk)

Yeah, if we restructure our portfolio a bit, sell off a bit of ComCorp, we may finish up in front (Bill talk)

Karen and Bill and Jean and Greg were taking calculated risks with the share prices. The what if type behaviour was observed to occur in many different places in the program. Mick and Sharni also exhibited what-if inquiry when they tried to compare the broker's information with the company reports:

.The company reports are giving us all the information we need (Mick talk)

No, no, I think we should look in the broker's office and compare the quarterly reports. They might give us more information. I don't know if I trust the company reports (Sharni talk)

Oh, look, you're right, look at this graph. If this increase keeps happening we should make a few bob (Mick talk)

In this example, Mick and Sharni were interested in exploring to see if they could identify more information which would help them with their investment decisions. Mark and Simon made similar comments in which they demonstrated interest in looking around the program in case there was something more which would help them with their decision making.

You want to have a look round to see what's here, we might find something more to help us decide (Mark talk).

The acting out of what-if scenarios appealed to the students' innate interest in what might happen next, for example:

Gawd, I can't wait to see how we've done. I didn't expect this to be quite so exciting, I feel really stressed out (Jean talk).
I liked discovering when I click on something and think “oh, what’s it telling me this time?” (Marie interview)

It was evident from these remarks that Jean was looking to see whether her decision-making was proved correct. She also felt a level of emotional involvement which was necessary for initial interest to be aroused and maintained. Marie was looking for the program to alter her knowledge structure, at the same time as stimulating a level of attraction to various parts of the program. Most of the other students also displayed interest in what was happening in the environment and they were anxious to receive the feedback on their investments:

I think we had the butterflies, didn’t we? I got nervous when it came to making decisions each quarter, should we or shouldn’t we, and then waiting to see how we went (Bill interview).

We never knew what was behind the next door. It was nice to know that you could look at the shares and you could go to the next quarter and know immediately what was happening and decide on that basis more quickly (Karen interview).

I enjoyed the fact that I wasn’t sure what was going to happen next, it kept my interest going (Jon interview).

Kelly, Bill and Jon all felt that their interest was stimulated, Bill by wanting to see how well he did in his investment decisions, and Karen and Jon wanting to know what would happen next.

This form of activity was evident in all groups in many places in the program and played a large role in developing a form of curiosity in the students’ behaviour.

Sensory Inquiry

The students all displayed sensory inquiry to varying degrees in using the program. Typical behaviours included clicking on objects in the graphical interface to see whether it was an “Easter Egg”, an object which, when clicked, does something unexpected and surprising. Easter eggs are usually secretly written into the computer code to be discovered by the person using the program, providing them with a surprise effect, as evidenced by Mark and Simon’s conversation:

You wanna click on the flower, see what it does? (Mark talk)

Bummer, it doesn’t do anything, thought it might do a little jig or something (Simon talk).
Mark and Simon were not the only students to display this sort of behaviour; several students mentioned their curiosity in their interviews, for example:

I liked warping and checking Sean and Wanda, I looked forward to seeing how they went. I didn't bother much with Sean, but I compared pretty well with Wanda (Ted interview).

Ted was showing a degree of curiosity when he warped and went to see whether his decisions were as successful as Wanda's (the on-line helper).

And Mark T found that it was the stimuli of the colours and the characters which piqued his sensory interest:

I found myself attracted to the characters, the little extras like the phone and to and the great graphics, they made me want to explore more (Mark T interview).

You know, all those colourful bits, the people, the animations, all of them kept me amused and made we want to do more of the program (Mick interview).

These students were attracted to the graphics, the animations and the other sensory stimuli such as the tv and phone. The graphical environment with its abundance of objects and concealed data provided frequent opportunities for the students to experience a form of sensory inquiry. These features were significant components in the curiosity engendered by the program among its users.

Summary

An important feature of a motivating environment is the degree to which it can arouse and satisfy curiosity. Curiosity was stimulated by having unknown features and by including "warps" which allowed the students to make a decision and then see the results of that decision. Curiosity is in place when elements such as novelty, exploration, surprise and sensory inquiry are present. An optimal level of complexity is an important ingredient in motivating environments and incongruity or discrepancies can play an important part in increasing the surprise levels and expectations of the learner (Malone, 1981). There were repeated examples of these behaviours being experienced by the students using Principles of Financial Investment leading to the conclusion that the exploitation of students' natural curiosity was a strong feature of their use of the program.
All the learners explored unknown components of the program, they all investigated the results of hypothetical transactions, they all followed information trails and they all explored visual aspects of the program's interface and in each and every case these actions were taken to ascertain no more than where they would lead and, in so doing, the learners were exhibiting strong signs of curiosity. Constantly throughout the program the learners asked the question “what would happen if...”, and again this question is a strong indicator of the presence of real curiosity.

In general, the students exhibited different types of inquisitiveness whilst using the program. Some questioned each other about what the program would offer next (eg. what might be through a door); some discussed whether they had applied the information correctly (eg. whether they had made a profit or a loss, or whether they had followed the same pattern as Wanda, the on-line expert); and some investigated to see what new information might be offered to them (eg. what might be on the news).

Curiosity was an important and necessary feeling for the students for successful use of the program, as it was their natural inquisitiveness which caused them to explore to locate relevant and meaningful information. For example, when they clicked on the telephone to receive the insider trading information was an act of curiosity; and if they weren’t curious enough to click on the tv, they wouldn’t receive the information on world events which impacted on the share prices. Every student accessed these alternative sources of information to some degree, whether they were in a pair or working alone.

**Fantasy**

Fantasy was another learner effect considered to be essential for creating engagement in the program. Fantasy used in a multimedia landscape can assimilate experience into the learners' existing knowledge structures with little need to accommodate the demands of external reality (Malone, 1981a). The experience of fantasy means that learners are able to use their imaginations to put them into a situation outside their immediate experience or they may relate the unfamiliar make-believe environment to their real world experiences.

Many of the students demonstrated signs of fantasy behaviour by acting in the scenario in which the activity was embedded and by showing an ability to forecast
events. They also demonstrated a shallower form of fantasy by trying to increase their personal wealth. There was also evidence that students blurred the fantasy of the program with current events in the real world, and the fantasy of the environment helped them to transfer new material to both real world scenarios and relate it to existing knowledge structures.

In *Principles of Financial Investment* the problems were presented in terms of the elements of the fantasy world and the feedback received was both authentic and constructive. These are both elements of *intrinsic fantasy* where the fantasy depends on the skill, but the skill also depends on the fantasy (Malone, 1981a). Malone (1981a) claims that intrinsic fantasies are both instructional and interesting, and an advantage of them is that they often indicate to the students how the skill could be used to accomplish some real world goal.

**Experiencing cognitive aspects of fantasy**

Metaphors can help the application of previously learned material to the understanding of new material. Several of the students found that, because they were able to relate the new material to some of their old knowledge, they were able to understand it more easily:

> I found that I had a bit of understanding from stuff I'd learned in accounting and law and this really helped me to understand some of the new things (Marie interview).

> Do you remember doing some of this stuff in Accounting? (Mick talk)

> Yes, I didn't understand it too much, I couldn't make any sense of it. Seeing it like this I can see how it all fits together, the pictures really help (Sharni talk).

This relating of new information to information learned in previous courses is an important advantage of a multimedia environment such as this program. As Sharni found, another cognitive advantage of using a fantasy environment is that the vivid mental images may help the learner to understand and retain the information.

**Blurring of reality and fantasy**

The use of a metaphor not only enabled some of the students to relate new content to old knowledge, but it also helped them relate the situation to their own lives. There was considerable blurring of the line between reality and the fantasy of the program,
where Karen and Bill started relating a fantasy situation which relied on approval
from the Cuban government to Castro, who had no part in the program:

It’s a bit risky, they’re waiting on approval from the Cuban
government (Karen talk)
It’s very risky, yes. What happens if Castro carks it or something,
you’ve got a problem. Um, I don’t like that (Bill talk).

Karen and Bill were quite nervous as to effect on the share market
although his existence wasn’t part of the program’s what-if scenario. They also spent
time relating current events to what could be happening in the microworld’s market:

Well the thing is, is that there was a strong rumour that Hong
Kong’s sharemarket was really going up and up just prior to the
takeover because mainland China was supporting it. They were
throwing in all this money to support the share market say “hey
look, the share market’s really confident about the takeover” (Bill
talk)
Yeah, it’s a bit… (Karen talk)
Manipulation going on there (Bill talk)

Again, although China’s takeover of Hong Kong had nothing to do with the
program’s what-if scenarios, Bill obviously was thinking about the effect of this
event on the fantasy sharemarket as he and Karen kept trying to take this into
account when making their investment decisions.

Mark and Simon also tried to relate what was happening in the program to some
current events:

What do you think heart strain is? Do you reckon it’ll make much
difference to the prices if he pegs out? (Simon talk)
Yeah, remember the CEO of that car company in Malaysia who died
in a plane crash or something? It sent the market for those shares
into a frenzy ’cos he was the only one who was any good. D’you
reckon old Frank has a decent number two? (Mark talk)
Dunno, haven’t heard it on the news, maybe it’s in the quarterly
reports or somewhere (Simon talk).

Here, they are trying to gauge the impact on the market if the CEO dies as rumoured
and are relating it to another, real, CEO who died with catastrophic results in the
marketplace for that company. The blurring of fantasy and reality caused them to
think through the expected and unexpected effects of the CEO dying.

Greg also blurred reality and fantasy, but in a different way. He behaved as though
the on-line experts were real people and treated their advice accordingly:
Sean's a bit of a sack, it's obvious he's not going to make any money. What a fool (Greg talk).

Greg decided that Sean was not a character to take seriously and chose to ignore any advice he might have to give.

There were several examples of students treating the money as though it were real and it belonged to them, as typified by Karen and Bill:

- All Lion Oil [one of the fictitious stocks] needs to do is to find some oil in Bass Strait, something like that (Bill talk)
- Yeah, we could be rich (Karen talk)
- We buy it real cheap, then it will go through the roof (Bill talk)

Karen and Bill kept relating the fictitious stock back to the real world and their own lives by fantasising about becoming rich.

Three of the four pairs of students experienced a blurring of the lines between reality and fantasy. This helped them to relate the program to their real world experiences and kept them involved in the metaphor of the program. It was interesting to note that none of the single students verbalised this experience and it must therefore be assumed that they did not relate the metaphor to their own lives as strongly as the dyads.

**Forecasting**

The ability to foresee trends and forecast what will happen is part of the fantasy of share investment. There were repeated examples to show that at various times the students were fully enrolled in this attribute:

- You can gaze into the future I found it quite fascinating, with very accurate synchronisation between the various sections of the program. All the bits of information added up to making it a realistic environment. I had to apply theory, think about what I was doing, try to visualise what was going to happen in the markets, second guessing everything. (Jon interview)
- But our portfolio value has gone down, I think we lost about 8 or 9 grand in the DNA crash (Bill talk)
- I don't think we should get rid of them yet (Karen talk)
- No, no well I can't see they'll go down much after that (Bill talk).

OK, look at the graph, there's a definite trend upwards for ComCorp, what d'ya reckon, go a bit more? (Mark talk)
- Mmm, yep, it's definitely going up, all the market indicators point
to a buoyant market in the next quarter, I reckon we should give it a go. Five thousand more? (Simon talk)

These three incidences show that these students were enrolled in the fantasy of the program by trying to forecast what was going to happen in the future, with Mark and Simon reviewing and following trends.

Other students also became aware of trends occurring within the program and began to act on them:

What d’ya think, Castle Mining? (Sharni talk)
Na, they’re overvalued, we’ll do our dough (Mick talk)
Yeah, but look at the trend, if we go back to Quarter -6 and follow through, you can see that they just keep going up. I think we should go with the trend (Sharni talk).

Trying to work out how much cash we could retain. Maybe we were too conservative, but we weren’t altering our investment mix a great deal except for the fact that Castle Mining, which we didn’t buy initially because we thought they were overvalued, and we saw the price kept going up so we jumped in and bought a few, in fact 5% [of total budget]. (Jean & Greg interview).

Sharni was carefully following the historical trends of Castle Mining as a predictor of future performance and in this way she was unconsciously applying one of the major goals of the program and the financial theory.

This recognition of trends and ability to forecast events was an important part of the fantasy aspect of the program, as the students began to understand how their new skills could be used to accomplish real world goals.

Summary

Fantasy is in place if one related the make believe environment to real world experiences or if one uses imagination beyond immediate experience.

It is clear that the majority of the students experienced fantasy to some extent. Several of the students mentioned the fact that the realism and authenticity of the metaphor helped them apply new information to their existing knowledge structures, and the imagery helped to cue appropriate cognitive behaviour and aided with memory retrieval.

Many of the learners actively “acted” in the various scenarios within the program, they actively tried to increase their personal wealth through accurate forecasting and
trend recognition, they either treated the fantasy as if it was the current reality or they blurred the distinction between fantasy and reality, they transferred the content contained within the fantasy both to the real world an to existing knowledge structures, and in so doing these learners were fully engaged within the fantasy world of the multimedia landscape.

Blurring of fantasy and reality could only be identified among three of the four pairs as it was obvious only from their conversation, but none of the single students mentioned having this experience. However, those who did relate the unfamiliar make-believe world to their own experience, talked about it several times and it was clear that it had a big impact on their decision-making.

Forecasting was mentioned by most of the students, where they spent time working out trends and predicting the future. The pairs and singles were enrolled equally in this attribute of fantasy and although not every student mentioned it, there were sufficient incidences to show that forecasting played a large role in the fantasy of the environment.

Many of the learners clearly felt, on reflection, that whilst the problems throughout the program were presented in a fantasy setting, the authentic and constructive feedback promoted the development of skills that did or would assist in the accomplishment of, what to them were perceived to be, real world goals.

**Challenge**

The final learner effect incorporated in the program was that of challenge. A number of researchers have highlighted the importance of challenge in motivation (eg Malone, 1981b). However, it was (Csikszentmihalyi & LeFevre, 1989) who defined the place of challenge in motivation by pointing out that challenge needed to be modifiable in order to be in balance with the learners' skill and to fall within their zone of proximal development (Vygotsky, 1978); that goals should be clearcut, personally meaningful and appropriate to the learner; that the learners should have the ability to set their own, suitable, goals; that feedback should be available on demand and be relevant and authentic; and that the presence of these things not only leads to increased motivation, but also a sense of personal efficacy, where the learner's self-esteem is engaged and enhanced.
For an activity to be challenging it should have understandable goals whose outcomes are uncertain; no single, correct, solution; unclear paths of action; difficult decision-making processes; and they should have clear criteria for performance (Malone, 1981a; Malone, 1981b).

Activities that provide evidence of students being challenged include having to plan and test hypotheses; the ability to accommodate difficult activities, rather than find them too easy or too difficult; and understand the goals of the activity and achieve them.

**Understanding the goals**

If students have a clear understanding of the goals of the activity, then they are more likely to be challenged as a goal implies that there is a point to the activity which the students will try to meet, particularly if the goal is presented in a way that calls on learners to use skills in which they are deficient (Malone, 1981b; Carrier & Jonassen, 1988).

There was strong evidence that the majority of the students demonstrated that they understood the goals of the program, and, judging from their talk and interview extracts, most of them felt satisfied that they had accommodated the level of difficulty and met the challenges. Although they had a clear understanding of the goals, several of the students found the decision making process difficult as they had to apply new skills as the following example attests:

> I felt clear about what I had to do right from the word go. I struggled a bit with the content at first, but once you start investing, you begin to see how it all fits together, makes sense and then I just thought "hey, this is Ok, I can do this" (Jon interview).

Jon's comment was typical of several of the students, who, although they understood the goals, were challenged by the content until they had worked through it, acquired the new skills, and then actually applied it in an authentic situation.

Several claimed that they liked the fact that they had the ability to set their own goals, Ted's comment is illustrative of this:

> You can make it as difficult as you want, by how much detail you went into, the tutorials and the theory of working out the numbers. You can specify your own difficulty level simply by how much you do (Ted interview).
Ted’s comment was typical of a number of students who worked out that they could
determine their own goals to a certain extent. His comment is an example of how
several of the students set emergent goals, arising out of the interaction between
them and the environment (Malone, 1981a). There were no examples of students
taking the easy way out by not applying the theory to the game of investing,
although it was acknowledged by one student that this was a possibility:

I suppose you could just take a punt by plugging in figures in the
buy/sell and sitting back to see how you did, but somehow we didn’t
want to do that. I guess the exciting thing about this is pitting
yourself against the program and seeing if you can do well. I guess
you could also take a no risk approach and not invest in anything
and keep all your money in the bank, but the tax department would
get the interest and where’s the fun? (Mark interview).

Although Mark felt that it was possible to do nothing and just gather interest, he
recognised that there would be no fun and no challenge in doing that. Mark saw
himself in competition with the program and felt that the challenge was in taking
risks.

Student talk highlighted the way in which some of the students worked out what the
program aimed to achieve and how the various components contributed to this. For
example, Greg and Jean discussed their understanding of the goals of the program
and determined the importance of them:

OK, I think we have to work out how the stock market works (Greg
talk)
We’re also supposed to understand why the market fluctuates and
what’re we supposed to do with the tutorials? (Jean talk)
They show us how to value the shares—see the objectives? (points at
screen) (Greg talk)
I think this is useful, let’s not skip over it (Jean talk).

From this conversation challenge was evident by virtue of the fact that students had
to work out what to do rather than simply following instructions. Hence they were
exhibiting evidence of being challenged.

Marie displayed an understanding of the goals in her interview when she said:

If I’m not wrong, it’s teaching people how to invest and how profits
and losses came about.

Marie’s understanding of the goals differed from Jean and Greg’s. Their
interpretation of the goals was to do with market fluctuations and share valuations,
whereas Marie’s goal setting was to do with investing and making profits and losses. This is an example of how student perceptions of program goals can differ when goals are implicit rather than explicit. This self-setting of goals is a key indicator of being challenged.

Another example of goal setting was when Karen and Bill spent some time discussing what they wanted to get from the program and how much return they wanted on their investments:

> Well, we won’t go for huge profits (Karen talk)
> So, 10% at least (Bill talk)
> Yeah, we want at least 10% (Karen talk)

and how to divide up their portfolio:

> So we’ve got $100,000. With long term investment are we gonna sort of be on a highly speculative footing on this one, or are we gonna be conservative investors? (Bill talk)
> I think we should be half and half, I think we should be a bit speculative (Karen talk)
> Well, let’s divide the portfolio into $50,000 and $50,000 (Bill talk)
> Well, we don’t have it all because we spent $200 on tutorials, and we don’t want to spend all our money (Karen talk)
> OK. So should we have 30,000 to play speculative, 30,000 conservative and 40,000 in the bank (Bill talk)
> Yep, sounds good (Karen talk)

Goal setting was evident in all student activities in one form or another, with several of the students using the skills being taught in order to achieve the goals they set.

> We found the program itself helped tell us what to do and it told us whether we’d achieved the aim when we warped. I guess our main goal was to keep improving our score [in the form of profits] and we found that quite difficult because we had to apply new stuff and then thinking through the repercussions of our decisions wasn’t all that easy until we warped and found out what had happened during the quarter (Jean interview).

Jean was verbalising the fact that although the goals were self-evident and there was performance feedback, she and her partner were taxed by having to apply new learning to the task and try to foresee events. Jean’s comment was typical of several responses by other students, suggesting that challenge in the form of utilising new skills to achieve goals was present for most of them.

Nearly all the students appeared to set their own goal levels, and every student claimed to understand the underlying goals of the program. Goal-setting is a key
indicator of being challenged, for without goals there can be no challenge. It is also important that the goals are achievable to enable an attainable level of challenge.

Achievable Goals

The ability to achieve goals is essential for increasing confidence and self-esteem. However, if goals are too easily attained or too difficult to attain they lose their challenge.

There were several examples of students who, having achieved their first goal, wanted to continue with the program. Mick and Sharni’s comments are typical of this:

OK, we’re doing well so far, let’s see if we can maintain it (Mick talk)
Yep, I’m keen to have another go [at investing], I’m feeling like I’ve got the idea now (Sharni talk).

Mick and Sharni were obviously confident with their progress, which made them keen to continue investing, testing their ideas and meeting new challenges.

Although emergent goals should be achievable, research has shown that goals which are easily attained quickly lose their challenge (eg Malone, 1981a; Papert, 1980). The benefits of having achievable goals which are neither too easy nor too difficult were echoed in other student interviews:

It kept the interest, anything that progressively builds keeps your interest, whereas if its well and truly over your head you lose interest and stop learning (Jon interview)

What I was expecting was a step by step guideline and you go into this area and then this area and then this area, whereas we were testing it and finding out where to go. I’m a person who likes everything laid out before me because I don’t want to make any mistakes so I found it off putting, but in the end I found it didn’t really matter where you went because the computer program allowed you to go to all different areas which made it much more interesting. In the end I was becoming more comfortable with it. And
Not having the hierarchy there, no knowing what to do, I thought that was quite challenging, discovering and things like that. That’s what stood out, not knowing where to go and what to do, finding your own way round (Jean interview).

Once we got going it was simple, we got the background knowledge first before we went in, it made us a bit more confident when we knew what we were doing (Greg interview).
Jon identified a key factor of challenge when he talked about losing interest and stopping the learning if the material was too hard. Other students found that simply being in an alien environment posed difficulties until they had explored to the point where they began to feel comfortable. The majority of students tended to find that the difficulty level was optimal as they were able to achieve the goals and gain in confidence.

Mick and Sharni found that the task was not optimal, but too difficult, which resulted in them losing motivation for that part of the program which they could not cope with, and they almost gave up using the program altogether. However, analysis of Mick and Sharni's interviews proved interesting as they testified that when the tutorial got too hard for them, they went to one of the other areas for the information, rather than continuing to struggle with the content or giving up. In this way, they managed to reduce the level of difficulty until they had mastered the basic principles, and then returned to the more taxing components. Sharni claimed that she didn’t learn anything from the program because it was too difficult, but in the next breath explained all the things that she had learned.

Actually we found it very difficult, the tutorials and things, so when it got too hard, we decided to get the information we needed from the broker and the library. ...we didn’t learn much, but now I know how the markets work and I know what to look for and I might feel more confident if I did it again (Sharni interview).

Sharni was giving a demonstration of how she set her own, achievable goals. When she found the tutorials too hard, she simply went elsewhere for information which was not as difficult to assimilate into her existing knowledge. Sharni was driven by a will to master the information, but needed to find a level that she could accommodate to the point where she felt confident that if she repeated the program she could master the content. In this statement she is exhibiting evidence of being challenged.

**Outcome uncertainty**

Outcome is a key contributor to challenge. If the learners are certain that they can either achieve the goal or not reach the goal, then the environment is not said to be challenging (Malone, 1981a). To be universally challenging, this uncertainty of outcome needs to be appropriate for a wide range of people and for the same individual at different points within the learning environment (Malone, 1981a).
There were recurring incidences that showed that students using this program exhibited uncertainty with the outcome of their investment decisions.

*Well, we’ve put a lot into Austbank, I hope they live up to it (Simon talk)*

*Hmm, well we did the calculations and presuming we’re right, the banking one should go up based on the valuations. Besides, the information in the broker’s office suggests we’re doing the right thing (Mark talk)*

*You mean you’d trust a broker?...well, no pain no gain... let’s warp and see what’s doing (Simon talk)*

Mark and Simon were by no means certain that the correctness of their decision will be borne out by the results of the feedback, but felt that they had made the right decision. The randomness of the program heightened Mark and Simon’s interest and kept them engaged with the program, but they were aware that the consequences of making the wrong decision would be a fall in their profits and this tended to make them more cautious. Marie had a similar experience with the program:

*I could never think that I knew what would happen, there was always something surprising to keep me challenged. Although there were clues, some of them weren’t real and we were really tested to check it all out (Marie interview).*

The randomness of the activities and the uncertain outcomes not only kept the students alert, but made demands on the students and kept them motivated.

From the evidence of interviews, it appears as though the pairs may have experienced greater degrees of challenge than the singles. They also were observed to discuss their goal setting and the fact that the outcomes were uncertain, but comments from both groups appeared to be equally positive about the challenge aspects of the program. Although Shami found the challenge to be too much for her, she was able to find other areas within the program which accommodated her level of prior knowledge and so was able to continue with the program and felt able to cope with the challenge levels in other aspects of the content areas.

**Summary**

To be effective as a motivator, challenge must be appropriately and delicately balanced. To attain that balance there must be a delicate blend, on the one hand, of understandable, appropriate, achievable and relevant goals and, on the other hand,
of uncertain outcome, varying solutions, differing action paths and difficult decisions.

With some qualifications, the learners clearly felt that the process as a whole developed new skills and learning and/or improved existing skills and learning to the point where, having with personal satisfaction met the perceived challenges, they felt that they had understood and adequately achieved the goals set by the program. Each learner had a different view of what the program aimed to achieve, yet the very fact that each learner was prepared to self set his or her achievable and desirable goals, is strongly indicative of challenge. The fact that the learners could randomly choose an activity (with uncertain outcomes) and the fact that they could (through the navigation process) increase or reduce the level of difficulty to reach (with some effort) their desired outcomes, clearly motivated the learners.

The students were able to judge for themselves whether they had succeeded in addressing and meeting the goals from the authentic and realistic feedback which was provided as soon as the students required it.

Students experienced challenge by being aware of and understanding the goals of the program, as well as being able to generate their own, emergent, goals that were within their zone of proximal development. The fact that learners could easily generate goals of appropriate difficulty contributed to the environment being both challenging and motivating. The majority of students also found that goals were achievable, relevant and authentic and that they experienced success leading to enhanced self-esteem and confidence.

**Discussion**

Research question 2 has described the extent to which the students experienced the eight motivational learner effects, and the following graph (Figure 7.1) shows the number of occasions in which the various learner effects were evident in the interactions of the learners as evidenced by their talk and actions. The non-collaborating students have not been included as, due to their lack of talk, it was almost impossible to tell what they were feeling during most of the program, and the difficulties associated with inferring from their actions alone, the extent of the various effects.
As can be seen from Figure 7.1, all of the learner effects were experienced to some degree, with some effects being evident most of the time. Other effects were present to a lesser extent, for example curiosity and fantasy, but all students experienced them at various times.

Karen and Bill provided the most evidence of immersion, but the least evidence of flow and play and few incidences of fantasy. However, this does not mean that they did not experience these effects often, it could mean that they did not mention them as much as some of the other students.

A review of the table below (Table 7.5) shows that most of the environment was fairly heavily utilised, with the free “What do you know”, tutorial 3 and hints being the most under utilised areas of the program. Analysis of student talk shows that they worked out fairly quickly that tutorial 3 was not as relevant as the other two tutorials, and the “what do you know section” was superseded by the feedback from other areas of the program. The table also highlights the fact that some of the areas were heavily used by the students and that the pairs and singles appeared to use the program differently. This latter issue was discussed more fully in Research Question 1.

Table 7.5. Time (in minutes) spent by each student in each module

<table>
<thead>
<tr>
<th></th>
<th>Reception</th>
<th>Stock Office</th>
<th>Viewing</th>
<th>Tut 1</th>
<th>Library</th>
<th>Buy/ sell</th>
<th>Tut 2</th>
<th>Broker</th>
<th>What do you know</th>
<th>Tut 3</th>
<th>Hints</th>
<th>Time outside modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simon &amp; Mark</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Karen &amp; Bill</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>4</td>
<td>36</td>
<td>18</td>
<td>2</td>
<td>30</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>12</td>
<td>15</td>
<td>11</td>
<td>19</td>
<td>9</td>
<td>4</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mick &amp; Shani</td>
<td>1</td>
<td>0</td>
<td>13</td>
<td>4</td>
<td>15</td>
<td>15</td>
<td>9</td>
<td>20</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Marie</td>
<td>1</td>
<td>1</td>
<td>18</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>19</td>
<td>0</td>
<td>23</td>
<td>4</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Jon</td>
<td>4</td>
<td>0</td>
<td>15</td>
<td>7</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>7</td>
<td>24</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Mark T</td>
<td>1</td>
<td>1</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Ted</td>
<td>2</td>
<td>1</td>
<td>22</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>15</td>
<td>6</td>
<td>16</td>
<td>0</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

The following table (Table 7.6) illustrates, and allows a comparison of, the percentage of time the pairs talk reflected the eight learner effects. It is obvious that some of the effects played a larger part than others, but these effects may have also been experienced in a non-verbal way and therefore these results are not definitive.
Again, students may have been experiencing the emotions without them being reflected in their conversations. The same holds true for the individual students whose interviews reflected the fact that they experienced these effects, but due to the lack of talk, it was impossible to tell where and when they experienced them.

The student interviews, therefore, are probably the best guide to the extent of each of the effects.

Table 7.6. Percentage of time the pairs talk reflected the 8 learner effects

<table>
<thead>
<tr>
<th>Pair</th>
<th>Immersion</th>
<th>Reflection</th>
<th>Learner</th>
<th>Collaboration</th>
<th>Flow/Play</th>
<th>Curiosity</th>
<th>Fantasy</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark &amp; Simon</td>
<td>16</td>
<td>29</td>
<td>11</td>
<td>32</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Karen &amp; Bill</td>
<td>38</td>
<td>20</td>
<td>9</td>
<td>26</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>36</td>
<td>20</td>
<td>11</td>
<td>27</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>37</td>
<td>13</td>
<td>13</td>
<td>17</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 7.6 shows the percentage of talk reflecting the eight learner effects. Again, due to the difficulties of analysing non-verbal interactions caution must be exercised with these results.

Table 7.6 shows that Mark and Simon's talk reflected the least immersion of all the pairs and yet they demonstrated significantly more reflective and collaborative talk. Although they were absorbed in the program and worked through it with minimal distraction, they didn't tend to treat the content as seriously as they other pairs.

Mick and Sharni used the least reflective talk which could be attributed to the fact that all the material was completely new to them. The other pairs had all covered some of the material in lectures, whereas Mick and Sharni were completely new to it. Their talk was really about the content, reading it aloud to each other and trying to understand it. This proved to be quite difficult for them and instead of spending their time reinterpreting the meaning of the material, they took much of it on face value.

The student talk was analysed using a spreadsheet to count each incidence, and this illustrated the degree to which the collaborating pairs experienced each of the eight motivational learner effects. Whilst all the students spent nearly all their time being
engaged with the program, it appeared that levels of immersion varied due to the
different behaviours displayed by the pairs. Karen and Bill were extremely serious
about the work they were doing, having lengthy discussions about what to do with
“their” money. Both Mick and Sharni and Mark and Simon seemed to be in more of
a hurry to finish the program. Although they spent much of their time immersed,
they did not appear to be as absorbed in the program as Karen and Bill.

Play, curiosity, fantasy and challenge were harder to measure from the observations,
but incidences did exist as evidence from student interviews attests.

Although there is a lot of evidence to show that learning by doing is more efficacious
than learning by listening (Harper & Hedberg, 1997), this study shows that situating
the learning in an authentic environment also gives the students an understanding
of how the environment works in reality as the students began to realise what it was
they didn’t know about the environment in order to function effectively within it.
This is very difficult to achieve in a traditional lecture situation as students tend to
not absorb the information as efficiently.

It is clear from some of the comments in the interviews that initially the students did
not feel comfortable with the degree of learner control given to them, nor with the
need for reflection, although they gradually changed their views on this as they
progressed through the program. By the end, several were saying that the strategic
searching and exploration was more useful as a learning experience than the classic
learning by transmission encountered in a lecture.

**Contribution of the eight learner effects to motivation**

Evidence from the video and audio tapes shows that an environment such as this is
very effective in engaging the students on all levels and that the students felt real
highs and lows of emotion as various times.

Although eight learner effects were distilled from the literature, it appeared, after the
study was completed, that some of the learner effects were complementary, and this
has been ascribed to the fact that the learning environment has many facets, any or
all of which can combine to create motivation and engagement; “it is this conceptual
overlap that raises hopes for a productive synergy” (Quinn, 1997). Jones (1997) takes it
one step further when he states “the environment is more than simply the sum of
disparate parts, but it is an entity in and of itself” (p 7). It is therefore almost impossible
to identify which of the eight learner effects contributed most to motivation and engagement, but it can be assumed that the combination of effects built into a program will greatly enhance the degree to which motivation and engagement are experienced.

The main advantage that the students found is that the program presented an experience rather than raw information. As Laurel (1991) states "Learning through direct experience has, in many contexts, been demonstrated to be more effective and enjoyable than learning through ‘information communicated as facts’" (p 119). Evidence from the study has shown that interactive multimedia has the ability to engage learners on all levels, emotionally, viscerally and intellectually and presents information in an holistic and integrated fashion where the learning environment becomes a “meta-environment” contributing to the change in students’ attitudes and behaviours as much as the knowledge contained therein.

Many of the students mentioned the fact that the environment motivated them in various ways, from wanting to do more of the program, to wanting more information outside of the program, and wanting to acquire more understanding on the ways in which world events drive share prices. They used adjectives such as “stimulating, interesting, educational, fun, motivating, absorbing, and thought provoking”. One of them said that she was considering changing her major field of study to finance as she had enjoyed the material immensely. The students attributed these feelings to the way the environment was constructed, the use of cartoon style graphics and the authentic use of information and feedback; the interactions either with a partner or with the system; the fact that they could work at their own pace, exploring, reviewing and investing; and the way the problems were presented which made them think about what they were doing.

The students had very few problems with working out how to use the interface or navigating around it. After a while they enjoyed the fact that they had the control and could go where they liked, when they liked without multiple mouse clicking. Although they do not have a great deal of experience with computers, several students commented on the fact that they did not have to drill through layers to get to the information they required.
Although all the students spent a large amount of time with the content, they used different types of content and the collaborating pairs talked reflectively about their actions and the information.

Several students also mentioned the fact that they appreciated the flexible time it took to complete the tasks within the program. It is clear that educational interactive multimedia needs to be designed so that students use the program for only as long as they require to either acquire or apply the learning.

**Summary**

The study has shown clearly that all eight learner effects were experienced by both the dyads and the single students to various degrees. It appeared from the study that students who experienced immersion had a compelling feeling of being in the environment, taking it and content seriously. This is a strong indicator of the presence of immersion. Reflection emerged as a possible difference between the two groups of students, with dyads exhibiting more reflective behaviours than the individuals. This could be because discussion promoted reflection, and the dyads' reflective thinking could be measured through discussion. Reflection was also a result of feedback received where students considered past, present and future actions. Again, this behaviour was particularly noticeable with the dyads, but could have been experienced by the single students.

Flow and play were induced by incorporating game-like elements into the program. There were many demonstrations of the antecedents of flow in the program, where students exhibited a balance between skills and challenge, focused attention and telepresence.

The collaborative aspects of the program highlighted the biggest difference between the students with the dyads questioning each other and reinforcing facts and opinions. The lack of a partner forced the singles to use the scaffolding aspects of the program. An outcome of the investigation on collaboration is the importance of having collaborative elements built into the program and the importance of accommodating collaboration.

Learner control was an aspect of the study that most students did not, initially feel comfortable with, wanting to be directed to specific areas. However, these students recognised the importance of self-regulation and could link it to their feelings of
motivation and engagement. The fact that the students took different routes to reach their final outcomes also shows the importance of learner control.

The curiosity elements enhanced the sensory inquiry of the students, giving them an incentive to explore and keeping them engaged in the program. One of the most striking outcomes of the students' use of the program was the way they blurred the lines between fantasy and reality. The students became active participants in the program scenario and although they knew the story line was not real, the authenticity of the environment, resulted in real world skills and knowledge.

In order for challenge to contribute to motivation, it must be at an optimal level. The students set their own learning goals and the authenticity of the environment provided them with sufficient feedback to allow them to determine their success in achieving the goals and to set new goals.

It is clear that each of the eight learner effects creates a complex set of outcomes, most of which contribute to the motivation and engagement of adult learners. There is also a degree of overlap between some of the learner effects inferring that they have a compounding contribution to the whole effect—in other words, they are more than the sum of their parts.

Research question 1 looked at how the students use a program designed to incorporate the eight learner effects identified as being necessary to motivate and engage adult learners. Research question 2 has investigated the extent to which the eight learner effects impacted on the motivation and engagement of the students.

Research question 3 will look at the ways the eight learner effects contributed to cognitive engagement.

**Conclusions**

The eight motivational learner effects described in detail within this chapter were achieved by the *Principles of Financial Investment* program in that an analysis of the collected data clearly shows that the learners when using the program all exhibited, to a greater or lesser extent, immersion, reflection, flow/play, collaboration, learner control, curiosity, fantasy and challenge. The results suggest that the components used in this program are successful indicators of motivation and engagement. To
achieve these effects in other interactive learning environments, several strategies can be employed.

To achieve immersion a program should readily facilitate and promote active participation and involvement in a realistic environment where the learners can both identify with it and become personally involved in it.

A means of incorporating reflection is to disseminate information from varying perspectives and through multiple sources. To aid the process of reflection the information should contain inherent inconsistencies or conflicts and should be both relevant and irrelevant.

To achieve flow, the creation of a program should facilitate the concept of play. Play can, in parts, be created through the introduction into a program's content of "what if" scenarios which can be undertaken by learners without the implications of failure and with the reasonable expectation of success and self-reinforcement. Further, play can be created through the provision of an environment that is intuitively interactive and which allows freedom of movement, random selection and exploration.

Collaboration is more evident when a program is used by two or more learners acting in concert. The program that formed the basis of this study clearly not only exhibited the many and varied aspects of collaboration by the paired learners, but also clearly demonstrated the benefits of scaffolding and coaching within peer groups. With learners acting alone and more so with paired learners, it is clear that a well developed program can itself become part of the process of collaboration if it is designed in such a way as to readily allow learners to consider, act upon and then reflect on the goal-action-feedback cycle. This cycle can be aided by the introduction of things such as hints and on-line experts.

It is suggested that to enhance the efficacy of learner control, a program should be developed in such a way as to allow learners to set their own goals and on the path to achieving those goals, the program should be created in a way that allows learners to freely choose (from a number of alternative and perspectives) the pace, path, content and feedback methods rather than taking a pedagogical approach where learners are treated as dependent.

In the case of curiosity, a program's development should encourage exploration and discovery through the use of sensory and non-sensory devices.
It is suggested that fantasy can be incorporated into a program's development through the creation of colourful and interesting characters (for example, on-line experts), through the use of vivid imagery and, perhaps most importantly, through the use of metaphors that actively encourage the ability to forecast events and foresee trends in circumstances where the learners, whilst clearly being aware that they are in an imaginary fantasy world, create associations or similarities with real world happenings or current events.

In the case of challenge, it is suggested that a program should be designed in such a way as to allow a learner to set, within the implicit parameters set by the program itself, personally meaningful and achievable goals.

Chapter 8 outlines the ways in which the program impacted on learner activities and cognitive engagement.
Cognitive Engagement

The previous two chapters have sought to identify the ways in which students used an interactive multimedia learning environment which was based on the principles of collaboration, learner control, reflection, immersion, flow/play, curiosity, fantasy and challenge, and how such a learning environment motivated and engaged the students. This chapter is concerned with exploring and reporting on the ways in which Principles of Financial Investment was able to encourage the growth of decision making and problem solving within an authentic and realistic setting. Such cognitive engagement promotes learner control, initiative, decision making, problem solving and experimentation.

3. How did Principles of Financial Investment impact on learner activities and engagement?

This chapter is concerned with the third research question, which looks at the nature of the student’s talk and lower order/higher order activity in order to explore its potential impact on learning. The study found that Principles of Financial Investment facilitated learning, not by changing behaviour, but by focussing on higher order skills such as reflection, challenge and learner control. Students had to choose their own navigational paths and solve problems which were sufficiently authentic that they didn’t feel as though they were “solving formulae for the sake of doing some maths” (Jon interview).

Cognitive engagement is observable when the learners are giving sustained, engaged attention to a task requiring mental effort and authentic, useful learning is produced by extended engagement in optimally complex cognitive activities (Cennamo, 1993; Corno & Mandinach, 1983).

Cognitive engagement and motivation are inextricably linked together through mental representations, monitoring, evaluation of responses and strategic thinking (Ames & Ames, 1989). Motivation is both a necessary condition for effective instruction, and the result of effective instruction (Winne & Marx, 1989). The amount of cognitive effort expended is an appropriate index of motivation as it relies on the
learner focusing on mastering the learning task and maintaining a high sense of personal efficacy (Shunk, 1989).

This chapter looks at the ways in which critical thinking was supported by interactive multimedia and the conditions needed in order for critical thinking to flourish.

There have been a number of scales designed to measure critical thinking, but they have proved inadequate when tested outside of their original study (Newman, Webb, & Cochrane, 1995).

Analysis of the student activities and talk should be based on the cognitive activities they exhibit, in particular:

- they should draw on their own experience;
- they should refer to theoretical material;
- they should refer to relevant material outside the course;
- they should initiate ideas for discussion (after Mason, 1991).

Analysing student talk to determine cognitive activity is a well established practice (see Alexander & Frampton, 1994; Marland, Patching, & Putt, 1992). However, this method had some serious drawbacks in that only collaborating students could be included in this section of the study. The students working alone were observed, but due to the lack of conversation, most of their cognitive activities were hard to isolate and define.

The discourse data collected was broken down into three main categories of activity—lower order, higher order, and off-task. The transcripts were coded by the researcher and then one was independently coded by two other researchers, both university academics. The researchers were given the transcripts and descriptions of what each category meant. Reliability was calculated using the formula as outlined in (Miles & Huberman, 1984, p. 64) where reliability equalled the number of agreements divided by the total number of agreements plus disagreements.

The aim was to reach 90% agreement (Miles & Huberman, 1984), and this was achieved by separate coding by each of the reviewers. Table 8.1 Shows the figures achieved in the first and second reviews:
Chapter 8

Table 8.1. Inter-rater reliability results

<table>
<thead>
<tr>
<th></th>
<th>Rater 1</th>
<th>Rater 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review 1</td>
<td>65%</td>
<td>82%</td>
</tr>
<tr>
<td>Review 2</td>
<td>92%</td>
<td>93%</td>
</tr>
</tbody>
</table>

After the first review, the researcher went through the data with each of the raters and reinterpreted some of the meanings for them, including correcting misconceptions about some of the responses. After the second review, both raters had achieved over 90% agreement with the researcher, thereby ratifying the coding procedure.

Analysis of the cognitive activities of the students using the program was used to identify the number of instances of the following learning activities:

- Off task activities
- Lower order activities
- Higher order activities
- Learning in an applied setting
- Independent learning
- Learning through direct manipulation
- Impact on attitudes toward the program

**Off Task Activities**

Off-task activities were identified as activities in which the students lost engagement with the program. There were only two examples of off-task activities with the pairs and were of a very short duration. Jean and Greg had a short discussion about having worked all day and being tired, and Mick and Sharni talked briefly about what the other student in the room was doing. No examples of off-task activity by Bill and Karen, and Mark and Simon could be found.

Other students referred to problems they had with the technology which they claimed distracted them from the program. As the program was a prototype there were still some problems with it which caused the computers to crash if students did something unexpected. These problems were noted and corrected for future versions of the program.
The incidence of off-task activity was so minimal in every case that it was not considered to be of major importance.

**Lower Order Activities**

Lower order activity was identified as any operational tasks requiring little more than mechanistic activities, needing almost no cognitive engagement, problem solving or decision making. The lower order activities in this study included such things as registering in the program, enrolling in tutorials, buying shares, writing down prices, watching TV, answering the telephone and warping between quarters.

In order to investigate the above research question, a case study analysis of the four pairs was conducted. The students' lower order activities were divided into three main sections—lower order talk, information seeking, procedural, and browsing. Information seeking was taken to mean any activity in which the students were actively seeking information, but were not making judgements about it. Browsing involved both unstructured browsing—looking around the program to see what was available—and structured browsing, by which the students looked around the environment for a specific object, area or activity. Procedural activities involved moving between areas, enrolling in activities, and any verbal exchange or activity to do with the computer hardware, software or task.

The following table gives an overview of the types of lower order talk identified (after Herrington, 1997):
Table 8.2. Summary chart of classification of talk by pairs

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-Category</th>
<th>Definition</th>
<th>Summary of student talk</th>
<th>Example of type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedural</td>
<td>Equipment</td>
<td>Any discussion regarding the hardware.</td>
<td>These comments related to the computer crashing.</td>
<td>M: Oh, the computer's stuck. We'll have to start again.</td>
</tr>
<tr>
<td></td>
<td>Software</td>
<td>Any discussion regarding the operation of the program or problems with the software.</td>
<td>There were very few comments of this nature, but one pair could see the desktop behind the program which caused one of them some difficulties.</td>
<td>K: Do you find it a bit disconcerting with all this behind it? B: It is a bit, yeah K: You're trying to read it and there's all the little bits.</td>
</tr>
<tr>
<td>Task</td>
<td></td>
<td>Any discussion regarding the requirements of the tasks.</td>
<td>This type of talk related to the ways in which the students decided to move through the program and the order of their tasks.</td>
<td>J: What do you reckon? Do you think we have to go back to the institute?</td>
</tr>
<tr>
<td>Browsing</td>
<td></td>
<td>Any exchange where the students were talking about looking to see what was available.</td>
<td>There were very few incidences of this type of talk. The collaborating students did very little browsing.</td>
<td>S: Let's have a quick look round first.</td>
</tr>
<tr>
<td>Lower Order</td>
<td>Information Seeking</td>
<td>Any exchange which was of a routine nature, such as agreeing, commenting without applying thought or judgement.</td>
<td>Talk in this category included many routine comments about the task.</td>
<td>G: Tell you what this program really brings some concepts back.</td>
</tr>
</tbody>
</table>

Karen and Bill

As shown in Table 8.3 Karen and Bill spent a total of 32% of their time in lower order activities.

<table>
<thead>
<tr>
<th>Procedural, equipment, s ware, task</th>
<th>Browsing</th>
<th>Lower order talk</th>
<th>Information seeking</th>
<th>Higher Order Talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
<td>18</td>
<td>3</td>
<td>68</td>
</tr>
</tbody>
</table>

Only 4% of this time was spent on browsing and information seeking. This is consistent with the findings in Research question 2, where it was noticed that collaborating pairs talked their way through the program and the problems rather than browsed. The following is an example of browsing comments made by Karen and Bill:

Karen What's this By the Stars stuff? Shall we look?
Bill: Oh (laughs) it's just horoscopes. What's your star sign?

This is an example of structured browsing, where Karen and Bill are looking for a specific activity. Ten percent of Karen's and Bill's talking was procedural. Although they had several conversations about the software, most of their procedural talk was task related.

Bill: Yep Ok. Oh that was cancelled
Karen: Oh yeah
Bill: So we just keep going, yep, and then Ok. Fair enough
Karen: Well we don't wanna go back here, done. Yeah its all cancelled so we'll go up here. We want to go, we'll go back to our office

The percentage of lower order talk (18%) by Karen and Bill reflected the fact that they spent quite a lot of their time discussing what they were doing:

Bill: Yes it is, yes of course it's all coming back to us now
Karen: Hmm good
Bill: Right
Karen: Now we can go on

These were routine comments which involved very little analysis and judgement, but were more customary in terms of how the students approached the task.

Karen and Bill spent a very short period of time in pure information seeking, where they did not voice any opinion on the material. Examples of such talk were difficult to find:

Bill: Stock exchange?
Bill: Shall we buy the shares?
Karen: Why don't we go stock exchange and have a look at them first
Bill: Ok see what we're doing

This example shows Karen and Bill seeking some information prior to making their investment decision, and it shows that they were prepared to uncritically review information which is a lower order activity.

Karen and Bill invested less than half of their time in lower order activities, with most of their talk in this category being procedural and routine. They spent almost no time browsing the program, instead preferring to talk their way through it, hypothesising about where elements would be and what aspects would be included.
Jean and Greg

Jean and Greg spent 48% of their time in lower order activities, as evidenced by Table 8.4:

<table>
<thead>
<tr>
<th>Procedural, equipment, sware, task</th>
<th>Browsing</th>
<th>Lower order talk</th>
<th>Information seeking</th>
<th>Higher Order Talk</th>
</tr>
</thead>
</table>
| Jean and Greg spent very little time (only 1%) on browsing, the bulk of their time (22%) being spent discussing procedural matters. An example of procedural talk shows that they discussed what action to take, or how to go about doing a task. The following is such an example:

Greg: Right, enrol?
Jean: Yes, definitely
Greg: Shall I just scroll it down?

There were several examples of lower order talk (16%), where Jean and Greg talked about what was happening but without any analysis or judgement. The following example shows Greg restating a fact which he has read in the program and is seeking affirmation from Jean:

Greg: Net present value is the current value or adjusted value on the discounted cash flow rates, huh?

Jean and Greg spent 9% of their time in information seeking without making judgements about what they found, for example:

Jean: Let's see what Sean and Wanda have to say about this
Greg: Yep, I'd like to know how they feel about this little price crash.

Jean and Greg were investigating what the on-line experts were saying in order to help them make a further investment decision as they lost money on one of their stocks. This is a typical use of their information seeking activity. They spent a comparatively short period of time in the activity, and tended to use it when they couldn't find their own solutions.

Mark and Simon

As evidenced by Table 8.5, Mark and Simon spent 50% of their time in lower order activities.
Table 8.5. Percentage of lower order activities performed by Mark and Simon

<table>
<thead>
<tr>
<th>Procedural, equipment, s/ware, task</th>
<th>Browsing</th>
<th>Lower order talk</th>
<th>Information seeking</th>
<th>Higher Order Talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3</td>
<td>25</td>
<td>7</td>
<td>50</td>
</tr>
</tbody>
</table>

They spent 15% of their time in procedural activities, where they spent time talking about where to go next and discussing how to perform the tasks. The following comment is typical of their procedural talk:

Simon  
Let's go to reception. OK cool, now where are we gonna go stock exchange, library, broker?

Mark  
I see, we've got all these different places we can get the information. What do you want to check out first, the library, the broker or the stock exchange?

Simon  
We'll go to the stock exchange and look what we've got first off and then we need to start looking at what shares are what before we start buying.

Mark and Simon had very few incidences of talk where they discussed the hardware and software. Most of their comments were task oriented and related to the operation of the program. Only 3% of their talk was to do with browsing, as the following comment typifies:

Simon  
What d'you reckon is in here? Oh, the broker, shall I look in the office?

Mark and Simon were exploring the program to orient themselves to its various components. They only did this once, right at the beginning of their session and appeared to get a good overview of the program. Twenty five percent of their time was spent in lower order talk, commenting on what they were reading and agreeing with each other, for example:

Mark  
Right, that's the formula for net present value. Do you want to move on?

Simon  
Yep, I've got the hang of it, have you?

There were many exchanges of this nature, where they were seeking affirmation that the other had understood what was read. A small percentage (7%) of their time was spent actively looking for information to help them understand what to do. Most incidences of their talk in this category were to do with suggestions that they look at the TV or check the economic indicators, for example:
Mark  

Let's check what the economic forecasts have to say about all this.

Mark and Simon spent half their time in lower order talk of various descriptions, using it as a device to help them navigate through the program and decide what to do and how to do it.

Mick and Sharni

Mick and Sharni spent the most time of all the dyads on lower order activities. Table 8.6 shows the breakdown into categories:

<table>
<thead>
<tr>
<th><strong>Procedural, equipment, s/w, task</strong></th>
<th>Browsing</th>
<th>Lower order talk</th>
<th>Information seeking</th>
<th>Higher Order Talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>4</td>
<td>25</td>
<td>13</td>
<td>48</td>
</tr>
</tbody>
</table>

Mick and Sharni spent just over half their time (52%) on lower order activities, with 10% of that spent on procedural matters. Unlike the other pairs, they spent some time discussing the operations of the software and the hardware, as the following extract attests:

Mick  

I keep double clicking and now I’ve lost the register before I put our names in

Sharni  

OK, well let’s go back out and start again.

Mick and Sharni had several exchanges similar to this, where they had to restart the computer when it crashed, and when they talked about how the software worked:

Mick  

Where do we get the money to invest? Oh, I see the program gives it to us.

They also spent the largest percentage of time of any of the pairs on browsing through the program (4%). Although the percentage was not high, they did take longer than the other dyads to orient themselves to the program and the way in which it worked.

Mick and Sharni spent 25% of their time in lower order talk, where they tried to memorise the tutorials rather than apply the information to their investment decisions. Sharni was the main culprit in this as she was very keen to “learn” the material, as evidenced by the following quote:

Sharni  

I really want to learn this, so can you wait while I try to remember it. I might need to write it all down.
This memorisation involved copying down the text, repeating the information several times and panicking when she couldn't remember it. The following example is one of several of this nature:

Sharni Oh God, I can't remember this. Can you remember it? We won't pass the exam unless we can remember it.

Mick I think we should read it, work out the examples to understand them, and then have a go at the investing.

Unlike Sharni, Mick has recognised that if they complete the on-line examples and then transfer that information to the investing, they may have a better chance of understanding the information which is more important than memorising the information.

Mick and Sharni spent 13% of their time looking for information. This may have been brought about by the fact that Sharni was attempting to rote learn the information, and because she couldn't remember it she was reluctant to apply any of the theory. They tended to rely fairly heavily on the information in the broker's office to make their investment decisions, for example:

Sharni I think we should see if the broker will tell us how many Castle Mining to buy, if any. I can see what's happening, but feel a bit scared about putting all that money into them.

Due to her lack of understanding, Sharni also demonstrated a lack of confidence to a certain extent and is therefore happy to rely on the judgement of experts, a fact pointed out to her by Mick when he gently chides:

Mick Sharni, you can't always rely on brokers. The idea is that we work it out so that we can make the decision in real life.

Sherni I know, I know. What do you think we should do then?

Although Mick and Sharni spent the longest time in lower order activities, some of this may have been brought about by lack of background in Finance and by their academic immaturity (both students were in their first semester of University). Sharni, in particular, seemed almost reluctant to think about the issues, clarify their meaning and scope and identify the answers or reason the strengths and weaknesses of their solution.

Discussion

The initial high percentage of lower order talk by students using the program was not unexpected, as the students explored and experimented with the structure of the
program. However, the incidence of lower order talk did drop away towards the middle and end of the time as students became more familiar with the structure and content of the program.

Although the amount of time spent in lower order activities varied between the dyad groups, they spent fairly similar amounts of time browsing. The main differences between the groups were information seeking (ranging from 3% to 13%), procedural issues (ranging from 10% to 22%), and lower order talk (ranging from 16% to 25%). The types of issues which contributed to the lower order activities were problems with the system, for example when Karen was distracted by the desktop showing behind the program, or when the system crashed. Some of the students also found that they needed to be directed to the paper-based instructions, although they still tended to want to talk through their navigational problems than read a manual.

Much of the lower order activity involved student talk which was of a routine nature, where students were agreeing, reading aloud, and commenting without judging. A much smaller percentage of the lower order activities involved information seeking where students were actively looking for information and discussing it without judging it.

**Higher Order Thinking**

Higher order thinking is viewed differently by different disciplines, depending upon their philosophical perspectives. One view of higher order thinking skills is that they depend upon the learner developing some lower order skills first (eg (Resnick, 1987). However, in this program the lower order and higher order skills were operated in tandem. Higher order thinking has been analysed in this study, as involving the process of monitoring one's understanding, imposing meaning and structure, raising questions about presented materials, reinterpreting the problems, and calling on a wide range of skills outside the immediate discipline being studied, as well as generalising current learning to new activities (Resnick, 1987).

The students developed some of the skills described above by having to make decisions about investment opportunities, value the shares, make decisions on the variety of information given to them, sift the relevant information from the irrelevant and plan their portfolios.
The following table presents each of the classifications together with corroborations from other authors in the area. The third and fourth columns relate these definitions to the ways in which the students used the program and gives examples of their talk in each classification.

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Example of student talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning/Strategy</td>
<td>Decision making (Lewis &amp; Smith, 1993), considering strategies and planning events.</td>
<td>&quot;Yeah, well I reckon that Castle Mining is overvalued so why don't we check out what the broker has to say about that, and then maybe look at the quarterly reports to see if there's some sort of a trend?&quot; (Simon talk).</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Any statement expressing uncertainty. Any question clarifying a point (Ennis, 1993).</td>
<td>&quot;One point one, where's the 12 come from, percent, where's the 16% come from? Don't know?&quot; (Mark talk)</td>
</tr>
<tr>
<td>Predicting/Imposing meaning</td>
<td>Making a prediction, deciding what to believe, solving non-routine problems (Lewis &amp; Smith, 1993), making judgements (Ennis, 1993). Exploration of the problem, using inference, induction and deduction (Garrison, 1992).</td>
<td>&quot;Net present value is the current value or adjusted value on the discounted cash flow rates, huh&quot; (Greg talk)</td>
</tr>
<tr>
<td>Multiple perspectives</td>
<td>Establishing different perspectives (Duchastel, 1990). Grounding in the real world (Garrison, 1992).</td>
<td>&quot;I know, isn't that interesting, Northern Queensland, Western Australia, Cuba. I didn't know Cuba produced gold. I don't know what to do with the market at the moment 'cos you wouldn't buy gold at the moment&quot; (Karen talk).</td>
</tr>
<tr>
<td>Coaching</td>
<td>Accessing hints, help in the form of support, advice, explanations. Students teaching each other the material.</td>
<td>&quot;Yes D is probably whatever the figure that they say starting 6 years from now but its only 5 periods working here but it must be in the backdrop of the 5 periods.&quot; (Bill talk).</td>
</tr>
</tbody>
</table>

Karen and Bill

Analysis of talk by Karen and Bill shows that they spent more than half their time in higher order talking.

<table>
<thead>
<tr>
<th>Lower Order Talk</th>
<th>Planning/Strategy</th>
<th>Uncertainty</th>
<th>Predicting/Imposing meaning</th>
<th>Multiple Perspectives</th>
<th>Coaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>12</td>
<td>8</td>
<td>36</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

Karen and Bill spent 68% of their time on the higher order activities as described above. Of this, 12% of their total time was spent on planning activities, including strategic thinking. The following extract from Karen's talk shows her thinking through her strategy for one particular stock:
Karen: I think we should get rid of some of those Diversify shares and make a profit cause we bought them at 40 cents we earn 20 cents profit and they might go down and keep going. We wanna go to our broker.

Karen: Ok we wanna sell Diversify, we’ll sell half of them, we’ll sell 10,000. We should go buy some more, what do you wanna buy?

Karen has identified that Diversify may go down and keep going down, but is prepared to hedge her bets by only selling half of them. In this she is thinking critically and showing that she is prepared to take a risk, both thinking dispositions which are part of cognitive engagement.

Karen and Bill spent 8% of their time seeking clarification and exploring in order to overcome their uncertainties. The following example attests to this activity:

Bill: I’m not sure, is this insider trading or what? I don’t think we should act on the info until we know. Let’s try to ignore it for a minute and look at Castle Mining rationally.

Because Bill is uncertain about whether to act on the information because he’s not sure whether it is insider information, he has decided to look at the other information critically and assess the worth of Castle Mining on that information.

Karen and Bill spent 40% of the time in discussing what they were doing, coaching each other, checking each other’s understanding of formulae and concepts, and predicting and imposing meaning. The following extract of their talk is an example of both coaching and predicting and imposing meaning:

Bill: Ah this is interesting $4 no $14.30, so its actually, its actually cheaper

Karen: Now how did they arrive at that figure?

Bill: OK, it’s this formula here, Yeah from year 5 onwards. If 5 to infinity is deferred perpetuity it grows at 2% using the G.

The remainder of Karen’s and Bill’s time, 8%, was spent on investigating multiple perspectives. Multiple perspectives includes grounding the new information into the students existing knowledge. There were several examples of Karen and Bill doing this, including the one below:

Bill: That’s in billions. I think most of the mines around the world churn out between like 10 tonnes 5 - 10 tonnes

Karen: A year um
Bill: Not 90,000 tonnes in one year! Imagine trying to stockpile that little lot!

Karen and Bill spent quite a lot of time comparing some of the theory to material they had learned in other units, particularly Law and Accounting:

We did that in accounting, the earnings per share (Karen talk)
Section 201 has to be, unless you’ve got it out of the preference...the redeemable... (Bill talk)
Yeah, yeah (laughing), not what we learned in Company Law (Karen talk)
Well this is all Company Law too, isn’t it? (Bill talk)

They were able to ground their new information back into old information, and were also able to transfer it to other subjects. This is known as *sameness* or a generalisation applied to more than one event and is an example of the presence of higher order thinking (Grossen, 1991).

Karen and Bill were also keen to get several perspectives on some of the material, particularly as they warped through to the last two quarters. The following is an example of this:

Karen: OK, that’s what the economic forecast has to say about it. I think we should look at the quarterly reports

Bill: Yep, that stockbroker on the tv had a slightly different perspective on it too. Perhaps we’d better have another look at her.

The time spent on these activities is considered essential to higher order thinking as it denotes effort on the part of the learners (Resnick, 1987). Karen and Bill spent three percent of their time on off-task activities, and even here the time was spent sorting out a technical problem with the computer display. Apart from the 3% of time spent on off-task discussion, their talk was totally devoted to issues raised by the program and all activities were pertaining to the program.

Karen and Bill spent more than half of their talk time identifying reasons and assumptions, judging the credibility of some of the sources of information, clarified vexing questions, planned and judged their strategies and were cautious about some of the conclusions they drew. These are all examples of higher order activity and show a degree of cognitive engagement.

Jean and Greg

Jean and Greg spent 51% of their time in higher order activities, broken down into the five categories as shown in Table 8.9:
Jean and Greg spent 12% of their time considering strategies and planning their next course of action. The following comment by Greg exemplifies the fact that he was talking through a strategy for investing and planning his portfolio:

> Greg: OK, we've looked at all the prices, I think we should put at least $25,000 into the banking stock, that's a bit of a blue chip by the looks, so then we can afford to have a bit of a flutter on some of the others. What do you think?

Greg and Jean had several, similar, incidences where they looked at the longer term in planning their investment decisions and tried to develop strategies to maximise their earnings over a number of the stocks and in this way exhibited evidence of higher order thinking.

Of all their talk, 4% expressed some uncertainty about what they were doing. They had several conversations where they clarified information for each other, the following being an example of this:

> Jean: OK, look at this price, it seems to be increasing. We thought they'd go down, they're overvalued. How can they keep going up? Do you think we should bung a few thousand in them just in case?

> Greg: God knows! They're definitely overvalued, how's about we stay out for another quarter and reassess in the next round?

The fact that an overvalued stock kept increasing in price caused a degree of uncertainty for Jean and Greg. They repeated their valuation and questioned each other several times on the possibility of further price increases. This was a clear example of higher order thinking, where they were repeatedly thinking about what was happening and attempting to clarify the issues.

Twenty six percent of their time was spent on predicting and imposing meaning. They had several conversations about what some of the information was telling them and how that would impact on stock prices, as the following two comments by Greg attest:

> Greg: The price last quarter was $1.50 and they reckon it'll still go down more but there are no indications on the

<table>
<thead>
<tr>
<th>Lower Order Talk</th>
<th>Planning /Strategy</th>
<th>Uncertainty</th>
<th>Predicting /Imposing Meaning</th>
<th>Multiple Perspectives</th>
<th>Coaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>12</td>
<td>4</td>
<td>26</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 8.9. Percentage of higher order talk performed by Jean and Greg
Austbank. It seems a pretty steady stock and the company report confirms this.

Greg: Alright we've learnt that the bank will continue to grow in the foreseeable future. I reckon we'll get a market return in spite of the contradictions.

In this comment it is clear that Greg is trying to decide what he should believe and is trying to make a judgement “in spite of contradictions”, this ability to filter out incorrect information is a strong indication of effective cognitive engagement (e.g. Corno, 1983).

The final 10% of their time was spent applying multiple perspectives to their learning (4%), coaching each other (5%) and in off task activities (1%). Their coaching time was spent helping each other to understand and solve the formulae. They spent no time accessing the on-line hints and tips, preferring instead to help each other. They spent 1% of their time in off-task activities, where Greg asked Jean if she'd worked that day and commenting that he was tired because he had been working all day. Jean also told Greg of her forthcoming trip to Sydney. These were the only two incidences of off-task behaviour and both were of extremely short durations.

Jean and Greg had a few incidences (4% of their total talk time) of grounding the theory back to their own world, like Karen and Bill, they related the information to material learned in other units and were able to draw on their own experiences to make their decisions, as the following extract highlights:

Jean: I think the banking stocks are always good, look at the National Bank. I remember watching their prices going up and up after they were floated. I think we should put a bit extra into Austbank, they're bound to go the same way.

Jean is relating her background knowledge on banking stocks to the specific stock in the program and predicting that Austbank will perform in a similar fashion. This was not an uncommon phenomena for any of the pairs using the program.

Jean and Greg exhibited many incidences of cognitive engagement and higher order learning. They made connections with their existing knowledge, organised their approach to learning and continuously monitored and checked their learning, all of which imply high levels of cognitive engagement (Kinzie, 1990).

Mark and Simon

Mark and Simon spent exactly half of their time in higher order talk. Of this, only 2% was spent on multiple perspectives and coaching, spending the least amount of time
of any of the pairs on these two types of talk. They did not show the same strong inclination to relate the material back to their own lives or previous information they had learned, and they did not coach each other through the solutions as did the other dyads. However, 48% of their talk inferred that they did experience a reasonably high degree of cognitive engagement as Table 8.10 attests:

<table>
<thead>
<tr>
<th>Lower Order Talk</th>
<th>Planning /Strategy</th>
<th>Uncertainty</th>
<th>Predicting/Imposing Meaning</th>
<th>Multiple Perspectives</th>
<th>Coaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark and Simon</td>
<td>50</td>
<td>19</td>
<td>8</td>
<td>21</td>
<td>1</td>
</tr>
</tbody>
</table>

Mark and Simon spent 19% of their talking time planning what they were going to do and trying to think through strategies for their long term investing.

**Mark:** Let's go with Castle Mining, what do you reckon our rate of return should be?

**Simon:** About 10%. I don't think Castle Mining's going to perform that well, looks overpriced to me. What about Austbank?

**Mark:** OK, anything's better than DNA

Mark and Simon were deciding what investments to make and tying these decisions back to information learned in the program. They spent 8% of their time trying to clarify their information, questioning and judging the sources of information:

**Simon:** Should we believe all this stuff? Well who's writing this, very biased but who's writing it do you know what I mean. Wanna go through all, a quick look through all of them.

In this example, Simon is highlighting the fact that they shouldn't believe all that they are reading, that some of the sources are quite likely to be biased. He is thinking reflectively and is focused in deciding what to believe or do.

Mark and Simon tried to be well informed about the stocks in which they were investing:

**Mark:** Right, right, right. We've got all the info on ComCorp from the company reports, I think we now need to look at the market indicators and see if we can work out a bit more objectively what they're going to do. We've gotta get more stuff than in the reports, it is written by the company after all.
Mark and Simon had many examples of talk which were similar to this extract above. Twenty one percent of their talk was predicting and imposing meaning and in order to do that they occasionally brought in multiple perspectives, as in the example above, although only 1% of their talk was categorised as being on multiple perspectives. Mark and Simon also had very few incidences where they coached each other, accounting for only 1% of their talk. Occasionally one would remind the other of how to calculate a formula, but on most occasions they would just talk their way through the material.

Mark and Simon showed many incidences of cognitive engagement, from questioning the information sources, identifying solutions, developing a position on issues, and trying to be well informed about the stocks in which they were investing.

**Mick and Sharni**

Mick and Sharni showed the least amount of cognitive engagement (46%), although they did achieve reasonable levels as shown by Table 8.11:

<table>
<thead>
<tr>
<th>Lower Order Talk</th>
<th>Planning/Strategy</th>
<th>Uncertainty</th>
<th>Predicting/Imposing Meaning</th>
<th>Multiple Perspectives</th>
<th>Coaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>2</td>
<td>15</td>
<td>21</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

They spent very little time in planning and strategic thinking. This could have been caused by the fact that they struggled to accommodate the information and were slightly reluctant to make decisions, checking their judgements several times before committing themselves, leading to fewer incidences of cognitive engagement than the other dyads.

Fifteen percent of Mick and Sharni's talk reflected their uncertainty. They had many occasions where they clarified the information for each other and Sharni, in particular, had several incidences where she expressed uncertainty, for example:

*Sharni:* Mick, I don't understand how this formula relates to what we're doing. I need to go back and re-read all the information again, do you mind? I can't remember the formula.

Sharni needed to check the information several times before she was prepared to move on. She was reluctant to progress through the program before she had
memorised much of the information. This behaviour was most marked at the beginning of the program, by the time she had moved to Quarter 4, she began to relax and realise that the information was still there to refresh her memory if necessary.

Twenty-one percent of Mick and Sharni’s talk was related to predicting and imposing meaning. Mick, in particular, spent time exploring the problems, making deductions and coaching Sharni through the solutions. Again, most of this category of talk occurred at the beginning of the program when they were in the tutorials, although about 8% did occur as they progressed through the program. Six percent of their talk was in coaching, and although Mick did most of this, once Sharni had grasped some of the concepts she was able to help Mick through some of the decisions.

**Discussion**

The students’ talk gradually took on more higher order aspects as students became absorbed by the content and began planning their investment strategies. The degrees of higher order talk varied between the four dyads, as did the incidents that triggered it. These triggering events varied from relating real world events to the program’s events, relating new information back to old learning acquired in other units, judging new information and projecting outcomes of decisions. The incidence of coaching also occurred to various degrees, although only one pair utilised it in a very limited way.

The dyads tended to have fairly different examples of higher order talk, with Mick and Sharni doing very little planning/strategic thinking (2%) and Mark and Simon doing 19%. On the other hand, Mick and Sharni spent quite a lot of time (15%) clarifying statements and 21% of their time predicting and imposing meaning. Karen and Bill spent the longest percentage of time on prediction (36%) and also the longest percentage of time on establishing different perspectives (8%). Mick and Sharni spent the most time accessing the on-line support and help (6%) which is perhaps reflected in their monetary results and also some of their comments about their lack of comfort with the program theory.

A comparison of the time spent and total profits accumulated with the degree of lower and higher order talk shows a clear correlation. Karen and Bill who had the highest percentage of higher order activities made the most profit, and this
correlation holds true for the other three dyads. It also holds true for the time spent in the program with the exception of Jean and Greg who spent longer in the program than Karen and Bill but made less money.

Table 8.12. Comparison of lower and higher order activities with time spent and total profit made

<table>
<thead>
<tr>
<th></th>
<th>Lower Order Activities (%)</th>
<th>Higher Order Activities (%)</th>
<th>Time spent in program (minutes)</th>
<th>Total profit ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen &amp; Bill</td>
<td>32</td>
<td>68</td>
<td>103</td>
<td>39,345</td>
</tr>
<tr>
<td>Jean &amp; Greg</td>
<td>48</td>
<td>52</td>
<td>112</td>
<td>35,239</td>
</tr>
<tr>
<td>Mark &amp; Simon</td>
<td>50</td>
<td>50</td>
<td>101</td>
<td>23,500</td>
</tr>
<tr>
<td>Mick &amp; Sharni</td>
<td>52</td>
<td>48</td>
<td>92</td>
<td>22,080</td>
</tr>
</tbody>
</table>

**Learning in an Applied Setting**

One of the strengths of a program such as *Principles of Financial Investment* is its ability to link theory and practice. Students rarely have an opportunity to do this in a traditional lecture setting, but nearly all found that the inert knowledge they’d gained in the lecture was transformed into practical knowledge through using the program:

...what I've learned in the lecture which is really good, and then I applied it to the program, but what I learned on that day itself [when he completed the study] helped me to understand how the markets worked and the whole investment thing worked (Mick interview).

In other words, Mick enjoyed the fact that the tasks he was set were not isolated from reality but were part of the larger context of share markets and the impact of world events on those markets. This made the material relevant and understandable.

Other students found that they considered where the new skills and knowledge would be used in their own lives, relating it to their own experiences:

Certainly I had to reflect on my investment decisions and tried to relate them to the theory I had learned. I have a sneaking feeling that in practice, the theory doesn't come into play very much in share investment like it does in valuation. However, the skills I learned are useful to transfer to other areas of financial analysis. I was thinking where I was going to use the tutorials in practice, and discounted cash flows and that sort of thing (Jon interview).

A few of the students had some prior knowledge of the content material and they felt that not only did the program help them to remember some of that content, but it also extended the knowledge:

I think I have recollected a lot of things I was taught a long time ago, and I've come away knowing more than I did a few hours ago (Jon interview).
It was very easy to bring it all back [prior knowledge] using the images, etc (Greg interview).

I learned how the formulas were used in investing. I feel confident in my judgements now (Mark interview).

I learned how to go through the process before investing: decision making and problem solving (Simon Interview).

Such comments suggest that these students felt satisfied with their learning and confident in their abilities to make decisions and solve problems.

Most of the students felt that they were able to not only understand the concepts embedded within the environment, but the program allowed them to see how the concepts related to other aspects of finance. The complexity was sufficient that it fell within the students' zone of proximal development (Vygotsky, 1978), which is the distance between the actual development and the level of potential development in collaboration with more capable peers (Vygotsky, 1978). Hence students found that the gap between what they knew and what they could know became narrower, particularly when they were scaffolded by their peers and some of the program elements.

Another important factor is having the content and the application of the content interwoven. The traditional course presents the facts, concepts and procedures via lecture and textbook and there is no opportunity to put these into practice anywhere in the Business degree. This program focuses on the functional context of the acquired knowledge and it is clear that the students enjoyed this opportunity of putting the theory into practice within the program itself:

OK, cool, we've covered all the theory, shall we go and see how much we can remember? Do you want to start investing now? It’s gonna be interesting to see how it all happens (Simon talk)

Hey, this is much better than Finance 1, look how it fits in—all the book stuff with actually doing it. This is cool (Jean talk).

Sharni made several references to the situated aspects of the program in her interview:

Relating the subject to the real world, more linked, it’s easy for them to learn and apply it;

...yeah, it made it like real life, some bits and pieces made us think it’s not a game, it’s like a real life situation, like having your money to tell you which one [share] is important and which one is not;
...because within my lecture I found some people who couldn’t relate what the lecturer said to the questions what they do, so it’s very important to learn things to apply it, they should know the link between the things; they are even there every quarter giving phone calls and to news, saying that the managing director is dead and it’s more like real world things, sitting in your office, getting your phone and watching tv, something like that (Sharni interview).

In Principles of Financial Investment the tasks the students are asked to perform and the content they cover have been combined so that they have the opportunity to develop integrated skills in an authentic context and in an authentic manner.

I always think applying learning is fun, and this program certainly made me apply my learning. I enjoyed the characters, the little extra elements such as the phone and the thrill of wondering whether I’d made or lost money. I think it was an enjoyable way of being assessed on what you’ve learned (Jon interview).

Student comments infer that having control of the program increased their sense of learning, but also allowed them to regulate their learning:

When I find my own way around the program I become more understanding of it. I think it’s good because people have difference levels of learning so if I’m very confident about something I just go straight to whatever I’ve never seen before, I’ve never learned. I don’t want to waste my time going step by step (Mick interview).

These comments were echoed by other students who had similar feelings:

We could see exactly what was supposed to happen, that’s what was interesting, something happened and you’d have to work out why and you’d just go to the places you think appropriate to get the information—you had the control (Simon interview).

The way it was all structured helped me learn because I learned how to go through the process before investing, gave me the ability to make decisions and solve problems (Mark T interview).

We were definitely challenged with the tutorials. I think it made us think about how they’d worked it out and how it was done and that sort of thing sticks in your mind, you’re thinking about it, you’re working it out yourself (Karen interview).

I think the challenging part is to follow your intuition and apply the theory. If I didn’t feel challenged then I wouldn’t have learned. I felt challenged in how to go about making a decision. I didn’t want to make a loss, the challenge was in making the right decision whether to sell or buy, it made me concentrate more. The more challenging, the more you concentrate and then the more you learn (Mark T interview).
Some of the students found that they appreciated the fact that there was a wide variety of information available to them when and where they wanted it. This is known as “background on demand” (Reinhart, 1995).

I thought that doing the theory in lectures would help me, but having done the lecture I can see that I learned more doing the program because of all the different bits and pieces of information available. I could do them in any order when I needed them (Sharni informal comment).

Students were interested in the immediate and future relevance of the theory. They liked the fact that they could transfer the knowledge gained to their own lives:

One thing I found with finance texts is that they were so bland. At least this gives you some connection with a real life application. A lot of students can’t see the use for finance...this program would help a lot (Bill interview).

I really enjoyed being able to see where I could use this knowledge in real life. There is nothing so practical as a good theory (Jon interview).

It appears from these comments that these particular students not only liked the practical application of the theory, but they felt that it was important to their learning. There was a belief among the students that in traditional lectures they were encouraged to memorise the material to pass exams as evidenced by the following comment:

...and even the lecturer said, don’t worry, just go through this and you can forget everything. You just go through the motions (Bill interview).

The majority of the students found that they moved beyond this lower-level information processing and were able to think more critically about the content. They were able to select, synthesise and store elements of information and this allowed them to relate the information to their own lives. The richer information environment seemed to promote more meaningful verbal learning with many exchanges being of a higher order nature. This dissatisfaction with the means by which information is disseminated in lectures leads to the conclusion that the traditional role of the lecturer will need to change.

**Independent Learning**

From comments that they made, many of the students came to realise that their traditional mass lecture experience with the lecturer being in control of their learning
would change with this type of environment. Most students agreed that this was a
good thing:

I think it's all in the mind, you think the lecturer is going to put the
stuff in your head by magic and then you find that it's too hard and
you've got to read the book anyway to try to understand it. This
way at least you can play a game while you're learning. It's fun, it's
real and it's much, much better (Ted informal comment)

One student mentioned that he appreciated the inductive and deductive nature of
the program, stating that he enjoyed the fact that the material was presented in such
a way that he had to find it, work out what it meant, then apply it, and finally
interpret the feedback:

The program allowed me to develop my own problem solving skills.
Rather than just telling me what should happen, it gave me all the
information to work out, then showed me it all happening and
allowed me to see the implications of my actions (Jon interview).

A few of the students felt that the program would not replace the formal lectures
and when probed on this point responded that the lecturer is the person who sets the
exam and knows what's important:

...someone actually speaking to you who knows what's actually
going on, sets the exam and marks it (Ted interview).

This is a problem of the social culture pervading universities and if programs such as
Principles of Financial Investment are to become an accepted way of teaching and
learning, this ethos will have to be addressed first. It appears that the older students,
who perhaps have work commitments outside the university have less fears about
replacing the lecturer with technology:

I don't think the other students will like having a computer program
instead of a lecture, but for me it would be good because I work full-
time and study full-time and it would be a way for me to do things
in my own time, at my speed. I believe for myself that if the program
is implemented into the system it will be a great help, because if the
students own their own computer, can use it in their own time, they
don't have to use the textbook because the textbook is long winded
(Mick interview).

As students come to realise that the lecture is a forum for the dissemination of
explicit information—information that is readily available via other means—and that
the tutorial is the vehicle by which tacit information (of the sort discussed by Ted,
above) is conveyed, they could become more positive about the place of IMM in the
university curriculum. Lecturers may also have to restructure their courses so that all
tacit information is imparted in some other form or by some other means.
Nearly every subject in this study reported a strong dislike for lectures as a primary method of instruction, much preferring the interactive and active means of engaging in the content when they used the multimedia program. A typical comment was:

*I felt educated! The program allowed me to develop my own problem solving skills rather than telling me what should happen like in lectures. It showed me it happening and allowed me to see the implications of my actions* (Jon interview).

As 80%-90% of all teaching in universities is conducted via the lecture method (Thielens, 1987, April), student comments such as the above, should be attended to, especially in the case of mass lectures. Research indicates that twenty minutes is the average maximum length of time that students can concentrate in a lecture and retain the content (Penner, 1984), and yet with the multimedia program students were observed concentrating on content for up to two hours. The students alluded to the difference in concentration spans by talking about the different ways in which the content was delivered:

*We were active all the time, exploring, talking about what we were doing, having fun with the props, learning new stuff. We didn’t have time to get bored* (Jean & Greg interview).

And

*I couldn’t believe how fast the time went! I looked at my watch and thought whoa, I’ve been here all afternoon. Wish lectures were like that* (Marie interview).

Some of the students felt that the program helped them to retain the information and felt confident when using the program. This may have been because they could visualise what was happening, what had happened and what was going to happen, and they had a contextual framework within which to store the information. This is sometimes referred to as direct manipulation (eg. Shneiderman, 1982).

**Learning through Direct Manipulation**

Direct manipulation is the visual presentation of the working environment with objects being represented in a symbolic or mnemotechnical form which students would be able to visual easily or retain in memory effortlessly (cf. Shneiderman, 1982). The advantages of such a technique are described in the literature as being easily learned by new users, an increase in efficiency for expert users; and reduced anxiety due to reduced error rates (cf. Blattner, 1992).
Although direct manipulation was not one of the questions in the interview, some of the students referred to it several times:

[I have done a workshop unit previously] where we were dealing in companies and that was very similar in that each quarter we'd get returns...but there were no props, in fact we put raw figures in, but the props are much better (Greg interview).

Everything you see pictorially you can remember longer, so after the unit Finance, some people may have forgotten about it, but if they had used the program itself, after graduating you can still remember what to do because it's always in there, but for me I learn about accounting, you don't really pay attention to it, after you graduate you probably forget about it, but this, your interest is a lot more (Mick interview).

One of the main benefits of incorporating information in a mnemotechnical form is that students feel that they are learning the information more easily, thus increasing their sense of personal efficacy.

Most of the students enjoyed the multiple, concrete examples and found they enhanced their conceptual understanding. The following are a few examples of the students' comments:

It was good, because if you are making some money which means you have done something right, so it's great, it puts enjoyment into what you are learning. Some people say, what the hell am I doing, I'm not sure what I'm going to use this for in the future, but actually this has got to be real. You become more motivated because you know, this is going to happen to you in real life (Mick interview).

...not just finance, because [students] are afraid of finance and things like that, but you can actually see things working and you're more interested (Mick interview).

I was fascinated by the fact that I could make an investment decision and then look at what happened and all the things that had an impact on that decision. It definitely kept me motivated to keep going (Jon interview).

I can't believe how much easier it is than the lectures. The lecturer just writes the stuff on the board and we copy it down to learn for the exam. But this is real, we have to know how to value the shares so we can invest and make profits. We didn't really need to write anything down, it's all there, we can go back to it any time. That's how it would be at work (Marie interview).

There were many similar comments in the student interviews. The students working alone also found that they felt they achieved more by applying new knowledge to
concrete examples. It is clear that students also felt motivated by having the ability to apply their new knowledge to realistic and authentic situations.

"Learning in a naturalistic context is synergistic with the context; the learning outcome is an aspect of the situation" (Laurillard, 1993).

**Learning Outcomes**

There were several measures which provided some feedback, included pre-, post- and delayed post-tests (see Appendix 6 for an example of the test), and total profits made.

Results of the test are listed in Table 8.13.

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Delayed post-test</th>
<th>Time in program</th>
<th>Total Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen</td>
<td>8</td>
<td>19</td>
<td>20</td>
<td>103</td>
<td>39,345</td>
</tr>
<tr>
<td>Bill</td>
<td>6</td>
<td>19</td>
<td>20</td>
<td>103</td>
<td>39,345</td>
</tr>
<tr>
<td>Jean</td>
<td>3</td>
<td>19</td>
<td>20</td>
<td>112</td>
<td>35,239</td>
</tr>
<tr>
<td>Greg</td>
<td>4</td>
<td>18</td>
<td>20</td>
<td>112</td>
<td>35,239</td>
</tr>
<tr>
<td>Mark</td>
<td>2</td>
<td>16</td>
<td>17</td>
<td>101</td>
<td>23,500</td>
</tr>
<tr>
<td>Simon</td>
<td>3</td>
<td>17</td>
<td>15</td>
<td>101</td>
<td>23,500</td>
</tr>
<tr>
<td>Mick</td>
<td>0</td>
<td>15</td>
<td>13</td>
<td>92</td>
<td>22,080</td>
</tr>
<tr>
<td>Sharni</td>
<td>0</td>
<td>20</td>
<td>20</td>
<td>92</td>
<td>22,080</td>
</tr>
<tr>
<td>Marie</td>
<td>3</td>
<td>16</td>
<td>14</td>
<td>84</td>
<td>26,000</td>
</tr>
<tr>
<td>Jon</td>
<td>4</td>
<td>18</td>
<td>19</td>
<td>97</td>
<td>28,890</td>
</tr>
<tr>
<td>Mark T</td>
<td>1</td>
<td>14</td>
<td>12</td>
<td>82</td>
<td>13,540</td>
</tr>
<tr>
<td>Ted</td>
<td>0</td>
<td>12</td>
<td>10</td>
<td>93</td>
<td>17,250</td>
</tr>
</tbody>
</table>

None of the students scored particularly well in the initial pre-test. Mick, Sharni and Ted scoring zero as they had not covered any of the content before. However all students passed the post-test (10 out of 20) being a pass. Sharni, in fact, performed extremely well in the post-test, although she was the least confident of all the students as she worked through the program. There is a slight correlation between the results of the post test, the time spent in the program and the amount of profit made. With a few exceptions, students who spent the longest in the program performed the best in the test and achieved the biggest profits, providing quite a good correlation between time spent in the program, the post-test and profits made.
Chapter 8 Cognitive Engagement

It is the results of the delayed post-test that are the most interesting however, with several students actually increasing their scores. A follow-up telephone call elicited the fact that all these students had continued to learn about share investment and trading by reading the Financial Review, reading the financial pages in various newspapers and following share price trends generally. All these students felt that they now had an on-going interest in the topic and would continue to follow share prices. The students whose scores had slipped slightly all cited pressures of work as one of the reasons for not continuing their interest, but two admitted to not being overly interested in the subject generally.

One of the best measures of success in the program was the amount of money made and as evidenced in Table 8.13 this correlates with the time spent in the program. It is quite conceivable that the financial outcome could improve even more with another session with the program. This could be the focus of a further study with the program.

**Impact on Attitudes toward the Program**

This impact on attitude was considered to be an important outcome of the study as it has a direct impact on motivation.

In every taxonomy of the affective domain, attitude is an important category and incorporates an affective component, a behaviour component and a cognitive component (Martin & Briggs, 1986). Attitude has a major part to play in the way in which students will approach a computer based learning program. If students are antagonistic towards the concept of using IMM to learn, then their attitude may prove to be the biggest obstacle to their motivation and cognitive engagement.

All students participating in the study under review had completed a foundation unit in computing and were therefore comfortable using a mouse and were not afraid of using the computer per se. However, when asked about their feelings about using multimedia for learning finance, there was a marked difference between the men and the women both before and after using the program. These will be discussed in the next section on gender. The small number of students make inconclusive any assumptions drawn about age differences, nevertheless, the findings do indicate that some further research would be beneficial.
Chapter 8

Cognitive Engagement

Gender

Researchers have found that playing electronic games gives males an important edge over females; they feel more comfortable with the technology and use it with greater facility (Plunkett, 1997). This lack of comfort and confidence with computers then limits females in their career choices and career paths.

Rather than focussing on writing a specific piece of software for females, this research has attempted to identify elements which have universal appeal. Students were empowered to construct their own fantasy, choose their own levels of scaffolding and coaching, and select their own degrees of complexity—all elements which have been shown to have great appeal to females as well as males (Plunkett, 1997). Students using the program have shown that they can relate to the various components, enjoy the levels of complexity and don't just want to achieve mastery, rather they want an immediate experiential payoff without a steep learning curve.

These findings have been validated by the work of Brenda Laurel and Dale Spender (cited in (Plunkett, 1997), with Laurel stating that play is more important than entertainment.

It was decided to garner students’ opinions about how they felt about doing the finance program both before and after they had completed it. Although the results should be approached with some caution until follow-up studies are able to validate them, there does seem to be a trend which is related to gender. The sample size was too small to elicit any trends pertaining to culture or age. Open ended questions in the interview asking students how they felt about using educational multimedia for learning finance showed a marked difference before and after using the program.

Several differences were noticed in the choice of words for males and females as can be seen from the graph below:
Consideration of the subject matter as being boring is the only commonality between the male and female group, all other language used was fairly different. The males were more indifferent to the proposed program, with some minor feelings of apprehension and incapability, whereas the females were more cautious, incapable, apprehensive, uncertain, uncomfortable, nervous and unsure. Although the words chosen by the students may be attributed to the different ways in which males and females articulate their feelings, they do reflect the findings of Plunkett (1997) as elaborated on earlier in this section.
Although both the males and the females felt some positive attitudes before using the program, the words used to articulate those attitudes were different. The females felt interested, pleased, curious, privileged and fortunate to be given the opportunity to use the program, whereas the males felt confident and challenged with the words interested and pleased being used by only 25% and 50% of the males respectively.

There were no negative words used by either males or females after using the program, and the graph below indicates the breakdown of positive words used when describing their experiences.

As can be seen from Figure 8.3 the differences between males and females is a lot less marked in terms of positive attitudes, but again the choice of words is somewhat different. The females tended to use words such as pleased, interested, excited, privileged, fortunate, challenged and curious, whereas the men used interested, confident, comfortable, fortunate, stimulated and challenged.

It is useful to note the marked change in some of the words chosen by the women after using the program. Seventy five percent of females chose confident and comfortable, whereas prior to using it, none had used these words. This is considered to be an important change in attitude as it may filter through to other areas of computer use.

There was also a marked increase in some of the words used by the males, with a 25% increase in the use of the word confident, 75% increase in the use of interested,
25% and 37.5% increase in the use of *excited* and *curious*, and 100% increase in the use of the word *comfortable*. It is interesting to note that although 50% of the males had used the word *pleased* prior to attempting the program, none used the word after completing it, and although none used the word *stimulated* prior to using the program, 25% used it after using the program.

These results bear some similarity to a study conducted by Sanders & Ayayee (1997), although in that study the students were administered an opinionnaire with a list of words from which to choose.

Although the change in attitude in the women was obvious, there was also a marked positive change in the attitude of the men, leading to the conclusion that the program proved motivating to both genders.

**Summary**

This chapter has looked at the impact of a microworld such as *Principles of Financial Investment* on learner activities and engagement. Evaluation of the data has highlighted the way in which the program contributed to cognitive engagement and learning.

The data analysis for this chapter focused totally on the dyads, as it was impossible to clearly identify lower order and higher order activities when there was no talk present.

Out of the four dyads, three drew extensively on their own experience, relating their learning back to other subjects in which they were enrolled, and also relating real world events to the content. This is a major benefit of using an information-rich resource such as a microworld as the students can readily identify with the situation and it therefore becomes more realistic to them. Another benefit of using this type of learning environment is that students are able to refer to the theory and apply it to practice, and also refer to other, relevant material where necessary.

Again, three of the four dyads initiated several ideas for discussion, and in fact the debates grew quite heated at times as they thrashed out ideas and formulated opinions on their various investment strategies. This, then, is another benefit of using a multimedia program such as this in a collaborative way.
Most of the students found that they retained the information much more readily through visualisation. In this case, the graphics and the authenticity of the setting helped achieve this.

There were also substantial differences in the attitudes between males and females, both prior and post use of the program. Although both groups considered the subject matter boring prior to using the program, no-one felt this way after using the program. Again, this is attributed to the design of the program, integrating content with a realistic environment which has many gamelike qualities, making it fun to use.

**Conclusions**

It is clear from this study that the learners felt that the use of interactive microworlds within a university environment are at least an important, real and useful supporting tool to traditional teaching methods. The use of well designed interactive microworlds leads to learner cognitive engagement which in turn promotes greater degrees of concentration for longer periods of time. Further, if well designed, a program will drive learners towards greater levels of higher order thinking which in turn will assist in the ready attainment of implicit goals set by the program itself and explicit goals personally set by the learners.

The use of the game and its motivating and engaging factors created an environment which resulted in high levels of higher order thinking. The contribution of each of the individual learner effects was unclear, but it is clear that in combination their power to motivate and engage was positive.

The results of this part of the study also show that the program created cognitive engagement with high levels of higher order thinking through triggering events, that are as follows—the program provided information and data from various perspectives and sources and facilitated a real connection between that information and information and learning already possessed by learners. The program’s materials encouraged and indeed required, learners to judge and assess the credibility of potentially conflicting information, and to develop strategies to resolve those conflicts, to clarify issues, to solve problems, to experiment, to think strategically and critically, to sift information, to predict and impose meaning and to make judgements and decisions in spite of apparent contradictions.
The materials within the program were written to be understandable, interesting and relevant, not isolated from reality, and attempted to link theory to practice by requiring the application of content. In other words, the program attempted to focus on the functional context of acquired knowledge through the integration of skills in an authentic and realistic manner and setting. With all of the above in place, learners had, through engagement, a positive attitude to the program and became active participants in the venture. To minimise the level of lower order thinking, which requires by definition, little sustained mental effort, the program was designed in such a way as to reduce the level of operational mechanistic tasks and allowed easy flow, exploration and ready access to information.
Chapter Nine

Conclusions

This chapter gives an overview of the research conducted and the findings and describes the limitations of the study and recommendations for further research.

The thesis gives an overview of the development of an instructional landscape which situated the learning in a realistic and relevant environment, and an evaluation of that environment from a motivational perspective. The evaluation was conducted using a triangulation of various qualitative methodologies which produced a rich picture of how well the students were motivated and engaged by the program.

The qualitative data was reported as “thick” descriptions (Patton, 1990) to enable the readers to interpret what has been set and draw their own conclusions as to the usefulness of the outcomes and its application to other educational multimedia learning environments.

Overview of the Study

While educational interactive multimedia is frequently seen as a medium more suited to children’s needs, it offers many advantages for adult learners. One of the great strengths of interactive multimedia is that it can accommodate adults’ desires for self directed learning (Caffarella, 1993), allowing the learners to initiate, plan and manage their own learning. It allows for greater personal autonomy and it allows the learner to have control over the pace and timing of instruction (Caffarella, 1993). At the same time, the capacity of interactive multimedia to provide a novel and intrinsically motivating environment would seem to create a very powerful tool for adult learning.

The literature review in this study highlighted a need for the affective domain to be considered concurrently with the cognitive domain when designing educational interactive multimedia. The literature suggested that the two domains are inextricably intertwined, however, with many adult interactive multimedia programs, this is often not the case, as most emphasise the cognitive domain with little attention to the affective domain within their instructional design. As
educational institutions move towards alternative delivery systems and as adult learners demand more self-paced and resource-based learning, there will be increasing pressure to produce instructional multimedia materials which can meet these needs of the learner.

Eight attributes required for a learning environment to be motivating and engaging were distilled from the literature describing instructional design, computer-based learning, andragogy and learner motivation. The review revealed clear patterns between motivation and desired learner behaviour, and there was ample evidence that a program that incorporated these patterns in its design was likely to be engaging and to lead to enhanced learning outcomes. An instructional landscape was designed which incorporated all of the attributes and the design and implementation of the program are described in Chapters three and four.

The resultant program, Principles of Financial Investment, simulated a small part of a real environment through which the learners could explore and discover context specific information. Principles of Financial Investment was designed in such a way that the eight learner effects of immersion, reflection, flow/play, learner control, collaboration, curiosity, fantasy and challenge, would be experienced to some degree by the learners.

In its development, the program was subjected to a number of informal reviews to ensure its accuracy and reliability for classroom use and to determine the effectiveness of the various components. Heuristic evaluations during development, in the form of focus groups, were conducted which highlighted other minor problems with the program. The rationale for the reviews was to improve the program in any way possible, measure its effectiveness in terms of ease of navigation, motivation and engagement, and to ensure that all the elements worked in the way intended. Once the prototype was completed, a pilot study was conducted to identify any problems with the program or the data gathering instruments. Several revisions were made to the program in response to some of the comments made by students.

An in-depth study of the program in an instructional setting was then conducted using nine students, six working in dyads and three working individually, all of whom volunteered their time to test the program. All students were videotaped throughout their use of the program in order to gain data that could show the time
spent on the various tasks within the program and the level of off-task activity. The dyads also had their conversations and discussion taped to determine the effect of collaboration on the way in which they used the program, as well as exploring the levels of higher order thinking and task involvement that occurred. The students were then interviewed to gather information concerning their feelings and attitudes towards the learning environment, their enjoyment of the program and levels of motivation.

The study sought to determine the effect of an IMM microworld with the eight learner effects on the motivation and engagement and learning of adult learners. This main research question was divided into three questions, with a summary of the results of these three questions set out below:

**Findings of the Study**

**Research Question 1**

*How did students use Principles of Financial Investment?*

Students’ responses showed that all of the eight learner effects of immersion, reflection, flow / play, collaboration, learner control, curiosity, fantasy and challenge, played some part in creating and maintaining their level of interest and enthusiasm for the program and in doing so helped to sustain their motivation to use it.

There were, however, several differences between the ways the two groups used the program, the main differences were evident in the nature and levels of reflection and decision making. The dyads were observed to be far more reflective and strategic in their use of the program than the single students. The single students preferring to gain their information and understanding from the more informal parts of the program, from the on-line characters and from practical outcomes. The dyads on the other hand, deliberated more on the theoretical aspects and discussed and communicated among themselves to draw meaning from the theoretical information in order to develop more strategic approaches to their share investments. Although all students were active and engaged in the learning process, there were clear advantages and extended learning opportunities available to the dyads.

The study has provided tacit evidence of the advantages of collaborative groupings in the forms of observed learner activity, behaviour and outcomes that show that collaborative use is a more effective implementation approach. Furthermore, it has
highlighted the fact that in some instances, individual learners are likely to use some sections and information sources within the program in preference to others and to derive their knowledge and understanding from the more practical and applied components and information sources. The study has also demonstrated the success of the interface, its useability and functional integrity and reliability.

These findings suggest that it is important that multimedia programs have the capacity to accommodate the needs of both collaborating students and those working in isolation. This can be achieved by having multiple representations of information, as well as on-line scaffolding and modelling. There is also a challenge to provide flexible, self-paced learning that is not totally open-ended, but which has a number of meaningful paths that provide the learner with clear choices but that achieve the overall learning outcomes required in a course within a university environment.

The findings revealed that the learning environment was successful in enabling students to navigate intuitively and in a non-linear fashion, thus allowing the impact of the learner effects to be explored and investigated.

Research Question 2

The second research question explored the ways in which the program developed and maintained the eight motivational effects among the learners. Both student comments and their activities were measured. It was clear from the findings that the students generally understood the goals of the program and were able to become absorbed in the challenge. This temporary suspension of disbelief as described by Laurel (1992) is highly indicative of engagement and student comments in Chapter 7 highlight the fact that they were truly immersed in the environment and were absorbed by it.

The initial findings were quite supportive of the expectations concerning the motivating and engaging attributes of the eight learner effects. The interviews with students provided corroborating evidence that the various effects had helped to motivate student interest and to engage them in a meaningful learning activity. The students appeared to enjoy this holistic approach to learning and the eight learner effects provided the conditions to motivate and engage adult learners, and more importantly, facilitated a deeper interest in the content material. The majority of the
students expressed satisfaction with the process, which probably came about from using a variety of processes and materials in the learning environment. Although there were a number of different media for presenting the information, the students found them to be consistent and were able to build a familiarity with the software and the environment.

The study found that the learners enjoyed the interactive nature of the program, exhibiting no signs of anxiety, frustration or boredom. Comments elicited in the interviews show that students clearly exhibited signs of intrinsic motivation and optimal flow, forgetting about time, being unaware of surroundings and completing the program when they were asked to do only three quarters of it (in the pilot study). The novel, situated learning environment appealed to all students, regardless of individual differences and visual and audio cues helped with their mental models. The way in which the students experienced the eight learner effects are summarised below:

Immersion
Every student reported having a first person experience, where they felt they were in an investment environment interacting with all the essential elements of such an environment. It is also clear that students felt satisfied, understanding the goals and being able to work towards them intuitively.

Reflection
Student feedback showed that the program stimulated high levels of reflection among the learners. Students reflected on decisions taken and those needing to be made and a large part of the thinking was associated with the content being learned. A surprising and unexpected outcome from this section was the amount of time students spent considering the ethical issues which were a very small component of the program. This could be due to the design of the presentation of these elements—presenting them in a novel and unusual way.

Collaboration
The students had very mixed feelings on collaboration—those working in dyads enjoyed it, and those working alone enjoyed it and both groups had some reservations. To accommodate individuals’ feelings, it might be useful to consider implementation strategies where students have opportunities to both collaborate
and to work independently. Both settings have the potential to make different, but substantial, contributions to learning.

**Play/Flow**

None of the students showed signs of anxiety or frustration and several said that they were surprised at how quickly the time went. Observations indicated that all the students exhibited signs of "optimal flow" on various occasions. It is obvious that the program appealed to the students' affective domains and created an enjoyable and fun learning environment.

**Learner control**

Learner control is a major component of a motivating and successful learning environment and has been shown to be one of the biggest motivating factors across cultures (Alpander & Carter, 1995). Student's responses confirmed expectations that the high degrees of learner autonomy in the program would be seen as a positive and appealing factor. The control provided a means to strengthen the level of learner engagement and was seen by the students as a contributory factor in the learning process.

**Curiosity**

Curiosity is an important motivational aspect, providing students not only with sufficient interest to begin the program, but also to continue using it. It can also be used to create the forms and levels of interest needed to have students engaged until the completion of the program. This program was successful in stimulating the students' curiosity in a number of ways. All students recognised that their curiosity was an important part of the learning process. Interestingly, the program appeared to stimulate interest and curiosity of some students beyond the computer-based setting. It sparked an increase in the subject itself and led several students to meaningful activities outside the program. The stimulation of learner curiosity is a factor which appears to have significant potential given that life-long learning is a major aim of most adult education programs.

**Fantasy**

Although some responses received indicated that the students were interested in the extrinsic fantasy of making money, it is clear that the students were able to begin
predicting what was going to happen in the markets and felt that they were actually in an investment situation. The fantasy in this program provided a realistic and contextual setting for the learning and appeared a strong component in developing the interest and engagement of the students.

**Challenge**

The program presented many challenges to the students. The scope and depth of the content was challenging, and the conflicting information challenged the students to think about what they were doing and encouraged them to develop their own strategies for investment. The challenge of investing money wisely and profitably led students through the various stages of the program. The students made many comments on the challenges that they experienced but few of the experiences were seen as negative or limiting. The challenges within the program appeared to strengthen its ability to engage the students and to maintain their interest and enthusiasm.

There was a great deal of overlap between the various elements and this can be explained by the fact that in such a learning environment which has many facets, any or all of them can combine to create motivation and engagement. This finding has been supported by Quinn (1997) when he discusses the way in which conceptual overlap can increase productive synergy.

Analysis of the student responses highlights the fact that immersion, flow, curiosity, learner control, fantasy and challenge are intertwined to various extents. Learner control, challenge and curiosity have been shown to be antecedents or consequences of the flow/play experience, and that flow and play are close correlates. Learner control has also been shown to be a consequence of the flow experience (Novak & Hoffman, 1997).

Analysis of the data from research question 2 also highlighted some important motivational elements:

- using “props” increased motivation and learning by giving students visual and mental cues for the information;
- facilitation of direct manipulation allowed students to visualise the components of the content enabling them to transfer information to other situations;
• the implementation of a variety of processes and materials in the learning environment prevented students becoming bored;

• this type of program is able to augment learning with experience, thus enhancing its overall effectiveness;

• the motivation and mindful engagement (Salomon, Perkins & Globerson, 1991) that derives from such a learning environment stems not only from the novelty, but from the realism, interactivity, fantasy, challenge, co-operation and immersion that is a natural extension to its benefits (Malone & Lepper, 1987; Pstoka, 1995);

• this variety of processes and materials also transcended individual differences—students were able to find appropriate media which appealed to them;

• it was useful to take advantage of the “novelty” effect of motivation provided it was appropriate and within the range of skills of the students;

• designing a program to facilitate students working together can increase motivation by students scaffolding each other;

• a program of this nature has the capability of providing the students with an ongoing interest in subject;

• the situatedness of the environment helped the students to understand how the environment worked in reality, and the part played by all the different elements.

All the students observed in the study recorded evidence of experience of the eight learner effects to various degrees, and it was clearly evident that all eight learner effects contributed in important and different ways to the overall motivation and engagement of each of the students.

Research Question 3

The third question was *In what ways did the eight learner effects contribute to cognitive engagement?*

A number of strategies were used to explore this question. Observation of student use, by both videotaping and audiotaping them whilst using the program, pre-, post- and delayed post-tests, and interviews after using the program.
Students were encouraged to make comments on their learning outcomes in the interview. Although very few were actually interested in improving their grades in the course, several mentioned that they were interested in increasing their understanding of the content and wanted to apply the theory in a more practical way.

The observations of students using the program highlighted many different incidences of higher order thinking. Several of the students demonstrated planning and strategic thinking by observing trends and acting upon them, making long-term predictions, and planning their portfolio mix.

Uncertainty was evident at various times with all the dyads. The ethical considerations caused some degree of uncertainty for some of the students as they tried to work out whether the information they were given was unethical or not. Uncertainty was also evident in the ways in which some of the students sought clarification of issues and information, and questioning each other on the implications of some of the information.

All of the dyads demonstrated a willingness to explore the program, using inference, induction and deduction to predict or impose meaning from the information presented. This was the category of higher order thinking that the students were observed spending the most amount of time engaged in. Students demonstrated prediction and imposing meaning by questioning each other, identifying the impact of some of the information on stock prices, and deciding what information was correct.

To a more limited degree, all of the students spent time on establishing different perspectives. Two of the pairs, in particular grounded the information contained in the program back to the real world, and transferring theory learned in other units to the content of the program.

Although all the pairs engaged in coaching each other, three of the four were quite active in this regard, with the fourth pair using the hints and help provided by the program.

Some of the students had very strong views on the place of such a program in the curriculum, mostly agreeing that they would not want it to replace the tutorials which provided them with tacit information not readily available elsewhere.
However they all agreed that the lectures basically provided them with explicit information, most of which could be garnered from other sources, such as their textbooks and programs such as *Principles of Financial Investment*.

It is clear that motivation itself led to incidental learning, with some students finding that they were able to concentrate better. Students also found that they experienced transfer from the information in the tutorials to the "game". The setting acted as an advanced organiser to tutorial content, orienting the students to the subject and enculturating them to the topic. The students also found that they had a continuing interest in the topic, long after they had completed the program, with several reporting in follow-up conversations, that they had begun reading the *Financial Review* and the financial section of the local newspaper, as well as taking more of an interest in the price movements of stocks and shares. This continuing interest could also account for the fact that several of the students scored better in their delayed post-test than they had done in the immediate post-test. This on-going interest in the subject matter was seen as a real strength of using a program such as *Principles of Financial Investment*.

Most of the students talked about the program as a "game". The word game was deliberately never used with them as it was felt that it would colour their thinking on the program and perhaps cause them to treat it more lightly. However, several students identified it as a game within minutes of registering in the microworld and yet didn’t take it any less seriously. The fact that they saw the program as a game was a positive aspect as they tended to link it with the words fun, excitement and enjoyment.

Coupled with cognitive engagement was evidence of the positive influence of the program on students’ attitudes to learning. One of the biggest impacts observed in the study was the change in attitude of most of the students, and the differences between the attitudes of the males and females both pre- and post-use of the program. As evidenced in Chapter 8, none of the students had wanted to participate in an activity that had to do with Finance, and yet, at the conclusion of the study, two of the students claimed that if they had completed the program earlier they would have considered changing their choice of subjects to accommodate more finance and another student did, in fact, change her choice to concentrate on finance.
**Implications of the Study**

Incorporating interactive multimedia into University teaching and learning is not just driven by the need to reduce overheads, but also the need to reflect the direction in which society and organisations are moving. Increasing international competition for students impels educators to review some of their more traditional teaching methods in an attempt to improve the learning process, and at the same time create courses which can be taken by students both internally and externally.

One of the earliest insights into educational technology was that it increased the possibility of individualising the educational process to accommodate the needs, interests, current knowledge, and learning styles of each student. This has been corroborated by this study, as it was clear that the program could accommodate a diversity of needs, interests, cultures, age-groups and learning styles. The students showed neither boredom nor frustration with the program or the content as evidenced by the lack of off-task activities.

Evidence of learning advantages and opportunities were evident with the following outcomes observed in the study:

- More emphasis was placed on the acquisition of higher-order thinking and problem-solving skills, with less emphasis placed on the assimilation of a large body of isolated facts.

- Basic skills were not learned in isolation, but in the course of completing real world tasks which integrated a number of skills. Information was available on a needs basis and came in a variety of formats. This transfer from the theoretical world of share investment to the students’ own lives constantly pervaded the students’ talk.

- Student attitudes towards the subject matter underwent a marked change and this was reflected in the fact that some on-going motivation and interest in the topic was evident.

- The program gave the opportunity for collaborative learning if necessary. Collaboration helped students to articulate their learning and thus engage in higher order activities.
Chapter 9

Conclusions

- Where collaboration was not possible, alternative strategies for information gathering and decision making needs to be made available. This is evidenced by the divergent ways in which the pairs and singles utilised different resources for their information gathering, decision making and problem solving.

- The student was much more active in building his or her own knowledge and skills, rather than passively absorbing information transmitted by the teacher.

A clear link between critical thinking, social interaction and deep learning seems to have emerged.

Collaboration enables students to share knowledge assisting in the process of cognitive engagement and development. Immersion leads to the player investing effort in mastery of the program, and it is in this investment of effort that the opportunities for deep learning exist (Leyland, 1996).

The authenticity of the program allowed thinking skills to be presented concomitantly with the lower order skills, rather than after them. The advantage of this is that students can immediately see the reason for acquiring the skills rather than trusting that they will be important at some future, far off, point in their working or student lives.

Applying technology to units such as Finance can result in the:

- boosting of curiosity, through the use of novel aspects and “props”; 
- teamwork may be enhanced by using collaborative learning techniques; 
- changed role of the lecturer from disseminator of information to guide and mentor; 
- reemergence of the apprenticeship model by placing students into an environment that is both authentic and realistic. By situating students in an exploratory microworld, they uncover rules that guide the real world, encouraging the development of learning as a process, rather than a product; 
- reduced intimidation and frustration among students; 
- improved concentration and motivation through telepresence;
• access to more information (background on demand) through multiple representations of data;

• richer information environment to penetrate "media overload" and to encourage exploratory behaviour;

• Cost is often a factor in the lack of use of well designed interactive multimedia learning environments. *Principles of Financial Investment* was produced for less than A$10,000 and this was achieved primarily by eliminating the costs of graphic designers, while incorporating all the elements of good interface design as outlined in the literature. The use of stylised and simple graphics were not considered to be a limitation by the students, but were considered interesting and "off-beat", but without interrupting the valence of the program.

• This study has reinforced Laurillard’s (1993) statements that discussion, interaction, adaptation and reflection, must all be part of the learning process. Both dyads and individual students experienced these four elements to varying degrees, but it appeared that the collaborating students found them easier to achieve, thus emphasising the value of collaboration in learning;

• breaking down the walls of the classroom by advocating self-paced, resource-based learning that the students are motivated to use, and that encouraged students to engage in processes rather than watch processes.

The fact that the program was designed explicitly for adult learners means that students were able to bring their prior knowledge and experience to the process of learning. Consolidation of learning and rapid feedback were accommodated, both of which have been highlighted as important for the feelings of self-efficacy of adult learners. The students also reported the fact that they enjoyed the provision to structure their own learning, and that the learning was inferential and discovery based. Several students also reported the fact that they enjoyed the excitement of taking a risk and watching the outcomes.

The design of the interface is of paramount importance if students are to be engaged by it. The ecological, intuitive interface which eliminates almost entirely buttons and menus encourages immersion by situating students in an environment to which they can instantly relate. Care must be taken to create an environment in which the student has a first person experience and which eliminates all exclusivity.
The way in which the program is used is also important. As the program was a prototype there were some problems with it crashing. The program was rewritten during the course of the testing and the modifications were found to be a great improvement, particularly those made to the tutorials, linking the theory and practice more closely.

The advantages of using an immersive, interactive learning environment such as *Principles of Financial Investment* is that content may be covered in as much detail as in a traditional, didactic setting, whilst encouraging students to collaborate, either with each other or with elements contained within the program. The dyads generally found their use of the program to be an engaging and exciting way of learning, developing their critical thinking skills and improving their understanding of the whole process of financial investment theory. This form of learning and activity was far less evident among the independent learners and suggests the need for those seeking to implement and design similar forms of computer-based learning to consider collaborative use as a key element of the design.

The use of qualitative research in this study was useful in studying the impact of the design factors (e.g. the environment or learner characteristics) on the motivation and engagement of the students. Overall the study has shown:

(i) The way to successfully incorporate the eight learner effects into a program;
(ii) the success of these eight learner effects in creating a motivating and engaging setting;
(iii) the capacity of such an environment to create high levels of higher order thinking and cognitive engagement.

**Limitations of the Study**

Although it could be generally concluded that the instructional landscape with the eight attributes did motivate and engage the students, there were some limitations to the research.

- Due to the nature of this research, there was no time to measure long term retention of the content, although a delayed post-test was conducted. A follow-up study at some later date would be a useful way of measuring the degree to which students were able to retain their understanding of the content.

- The impact of the individual differences of learners were difficult to measure and account for. An example of this is culture. As all of the international students are
living in Australia they are absorbing local culture and customs and constantly modifying and adapting. This makes the separation of cultural differences very difficult. Testing the program offshore would be a useful means of testing true cultural differences. As the Faculty of Business had no Australian Indigenous people enrolled at the time of the study it was impossible to test the program on Aboriginals or Torres Strait Islanders, but the fostering of a link with an Australian University that does have such students enrolled in a business degree could be considered for the future.

- A limitation of the program could be that the problem solving took on a pattern with all the students. Testing the program with a larger group of students would highlight this situation and could call for the integration of more information, both relevant and irrelevant;

- Students could use the program for longer periods of time in some instances. Another study could explore the optimal time for gaining the most benefit from the program.

- Another limitation of the study was the fact that the program was used outside the teaching program, rather than as an integral and important part of it. A further study that presents the program in a contextual setting, ie. as a key component of a unit of study could identify further benefits of such a learning environment.

- The study did not definitively measure learning outcomes attributable to the enhanced environments, rather it sought to explore the learning conditions it could create and support.

- Due to the small sample size it was quite difficult to identify any differences with elements such as learning styles. A larger study could be conducted involved a more representative adult population. This would authenticate the approach for further interactive multimedia development.

Although a number of limitations have been identified, they did not diminish the integrity of the study, rather they limited some aspects of its generalisability to other settings.
Recommendations for Further Research

The study provides very promising results supporting the instructional design principles for adult learners. However, many questions arise from the study and further research is possible in a number of areas including IMM design, implementation and evaluation of IMM programs and their methods of application. The following sections highlight potential research questions that follow naturally from this study.

**Design**

- Can more generic descriptions be developed which will enable the eight learner effects to be applied in more general forms in IMM design?

- Could the current interface be redrawn in a more professional manner and then tested to determine whether any differences are observable in the way students use the program (e.g., whether they use it more efficiently or whether navigation becomes more intuitive)?

- The program was designed and developed with very limited funding which restricted some of the development opportunities. An interesting future study could include spending more money on the program and assessing whether the students experience a corresponding improvement in their learning experience and learning outcomes.

**Implementation and Evaluation**

- This study did not explore the relative impact of the individual effects on motivation and engagement. A subsequent study could be to explore and evaluate this to determine those attributes that have the greatest impact.

- Learning outcomes were not a major focus of this study. A subsequent study could conduct a more thorough investigation of learning outcomes, with a larger number of students;

- A further study with a larger number of students would be helpful in determining individual differences as they pertain to motivation and engagement in an instructional multimedia program;
• The international students who participated in this study were all residents of Australia. Taking the program off-shore would give a much stronger basis for measuring cultural differences as participating students would not have begun to adopt the culture of the host country;

• This study did not explore in any depth the degree to which time altered the level of engagement. A further study could be conducted to determine how the length of time students are in the program impacts on the depth of engagement;

• A further study could be conducted to determine what forms of learning are best supported (eg. knowledge comprehension, analysis, synthesis);

• The use of on-line agents for distance education applications could be investigated in conjunction with this program;

• An additional study could examine the ways in which Principles of Financial Investment could be used as a support/replacement for conventional teaching methods, and these results could be generalised to similar types of IMM.

Application

• An analysis of students’ navigational paths through the program could be conducted to discover whether a wider variation of routes is achieved. Integrating a wider diversity of information sources could be considered in order to encourage students to adopt different patterns of use;

• A subsequent study could investigate the methods of integrating interactive multimedia into the classroom, particularly into subjects which are taught by mass lectures;

• An investigation could be conducted into the changing role of the lecturer and the student, and the ways in which this change can be accommodated;

• An investigation could be undertaken as to whether more time spent in the program increased the profits made by students;

• Replicating the study with a larger number of students and triangulating the results with some quantitative data gathering methods such as the Course Interest Survey, Revised (Viechnicki, Bohlin, & Milheim, 1990) would verify the results of
this study and provide further insights into which aspects of the program provided the most motivation and engagement;

- An investigation of the applicability in other discipline areas/content forms could be undertaken;

- A further study could investigate the development of generic skills to support more general application of principles;

- The application of programs such as *Principles of Financial Investment* to the World Wide Web could be an issue for further study;

- An investigation into methods of encouraging teachers to use these and other principles in IMM design in general would be a useful follow-up study.

This study has highlighted the value and importance of developing IMM for adult learners with affective as well as cognitive objectives and the study serves as a means to inform and guide future IMM development. Although this study was undertaken in a fixed context and its explorations were limited to a discrete subject area, it is evident that the levels of enhanced motivation and engagement which were observed among the learners could be replicated through application of the design principles in other subjects and settings. The outcomes from this study strongly support the need for continued research and development to ensure that the full potential of IMM can be exploited in adult learning environments.
References


References


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References


References


Appendix 1—Extracts from storyboards
| Opening screen | 1.0 | Voiceover: | Welcome to Principles of Financial Investment. Click on the doors to go inside Investment House and begin exploring the program. | Doors as click objects | 1.0_aif |
| Reception/Lobby | 2.0 | Voiceover | Welcome to Investment House. Click on the register on the desk and type in your full name and press Enter. | If click on Register bring up text box for name. If click elsewhere replay voice message. | On Enter go to Screen 2.1 | 2.0_aif |
| Reception/lobby | 2.1 | Voiceover | Thank you for registering. You are now ready to begin investing your money. Click on the floor plan to go to the named areas or click on Help if you want hints and tips. | Help | On “Help” go to screen 2.3 | 2.1_aif |
| Reception/lobby | 2.2 | | | If click on Institute, go to Screen 3.0 If click on Stock Exchange go to screen 4.0, If click on Stock Broker go to Screen 5.0. If click on Office go to Screen 6.0 | |
| Reception/lobby | 2.3 | Voiceover & text | You can either explore Investment house by moving the mouse over objects and clicking on them to begin moving around the building and begin | If click on Hint go to Screen | 2.3_aif |

350
<table>
<thead>
<tr>
<th>Reception/lobby</th>
<th>2.4</th>
<th>Voiceover &amp; text</th>
<th>A good starting point in this program would be either to take the first course at The Institute of Sound Investment, or to try the Self-Test. If you want to return to the Lobby click on Done.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institute</td>
<td>3.0</td>
<td>Voiceover</td>
<td>Welcome to the Institute of Sound Investment. Click on any of the courses to get a preview before you enrol.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If click on Principles of Investment go to screen 3.1. If click on Share Valuation I go to screen 3.2. If click on Share Valuation II go to screen 3.3. If click on &quot;What do you Know?&quot; go to screen 3.4. If click on Exit return to lobby.</td>
</tr>
<tr>
<td>Institute</td>
<td>3.1</td>
<td>Voiceover</td>
<td>This is an introductory course on the valuation of investments using the Discounted Cashflow Approach (DCF). At the end of this course you should:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a) Understand why we invest</td>
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<td></td>
<td></td>
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<td>b) Understand the concept of the Time Value of Money (TVM)</td>
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<td></td>
<td>c) Apply DCF to the valuation of single pay</td>
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<td>3.1.alt</td>
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<table>
<thead>
<tr>
<th>Voiceover</th>
<th>Do you wish to enrol in this class and have $100 taken from your account balance? Click Enrol to begin Click Done to return to Institute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netscape 3.1.1</td>
<td>INSERT NETSCAPE TUTORIAL 1</td>
</tr>
<tr>
<td>Institute 3.0</td>
<td></td>
</tr>
<tr>
<td>Institute 3.2</td>
<td>Voiceover</td>
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<tr>
<td></td>
<td>This course follows on from the Principles of Investment course and applies the Discounted Cashflow (DCF) technique to the valuation of shares. At the end of this course you should: a know how to identify the cashflows</td>
</tr>
<tr>
<td></td>
<td>If Done then return to Screen 3.0 If Enrol then go to Netscape tutorial 3.2.1</td>
</tr>
</tbody>
</table>
generated by shares

b know how to identify and estimate appropriate required rates of return when investing in shares

c apply the DCF technique to value a share under the condition of
  no growth in dividends
  constant growth in dividends
  variable changes in dividends

d understand the limitations of such an approach

---

Do you wish to enrol in this class and have $200 taken from your account balance?

Click Enrol to begin

Click Done to return to institute

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<table>
<thead>
<tr>
<th>Netscape</th>
<th>3.2.1</th>
<th>INSERT NETSCAPE TUTORIAL 2</th>
<th>At the end of the course return to Screen 3.0</th>
<th>Tut2.doc</th>
</tr>
</thead>
</table>
| Institute | 3.3 | **Voiceover** | The course *Principles of Investment and Share Valuation* outlined the discounted cashflow technique and its application to the valuation of shares. 
This course will introduce you to the more practical side of share investment. | If Done then return to Screen 3.0
If Enrol then go to Netscape tutorial 3.3.1 | 3.3_alf |
By the end of the course you will:

a) know the process of trading shares
b) understand the dividend payment system
c) have a broad understanding of portfolio diversification
d) know where to go to source share and share market information
e) understand the price/earnings approach to share valuation and its relation to share DCF technique
f) have a deeper understanding of what drives share price changes

Do you wish to enrol in this class and have $300 taken from your account balance?

Click Enrol to begin
Click Done to return to Institute
Trading in Shares

Work your way through the questions. If you have a weakness in any of the areas above, it is suggested that you invest some money and take the courses before you embark on your share trading spree.

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<tbody>
<tr>
<td>3.4.1</td>
<td>List of questions with answer button next to them where appropriate</td>
<td>If click on wdyk.doc where appropriate answer reveal answer</td>
</tr>
<tr>
<td>Institute</td>
<td>3.0</td>
<td>If click on Information go to screen 3.5. If Exit go to lobby. If click ASX go to screen 4.0. If click on Broker go to Screen 5.0. If click on Office go to screen 6.0</td>
</tr>
<tr>
<td>Institute</td>
<td>3.5</td>
<td>Voiceover &amp; Text</td>
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</tbody>
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### Screen No Media On Screen

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<th>Screen</th>
<th>No</th>
<th>Media</th>
<th>On Screen</th>
</tr>
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<tbody>
<tr>
<td>ASX</td>
<td>1/4.0</td>
<td></td>
<td>Board showing current stock prices</td>
</tr>
<tr>
<td>Viewing Room</td>
<td>1/4.2</td>
<td></td>
<td>When click Done, return to 1/4.0</td>
</tr>
<tr>
<td>Library</td>
<td>1/4.3</td>
<td></td>
<td>If click on Stock 1 go to 1/4.3.1</td>
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<td></td>
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<td></td>
<td>If click on Stock 2 go to 1/4.3.2</td>
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<td>If click on Stock 3 go to 1/4.3.3</td>
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<td>If click on Stock 4 go to 1/4.3.4</td>
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<td>If click on Stock 5 go to 1/4.3.5</td>
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<td>If click on Stock 6 go to 1/4.3.6</td>
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<td></td>
<td>If click on Market go to 1/4.3.7</td>
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<td>If click on economic go to 1/4.3.8</td>
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357
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<td>Top Shelf</td>
<td>DNA Engineers Quarterly Report W1</td>
<td>Click Done when finished</td>
<td>When Done return to 1/4.3</td>
<td>stock3w1.doc</td>
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<td>Top Shelf</td>
<td>AustBank Quarterly Report W1</td>
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</tr>
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<td>Library</td>
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<td>Top Shelf</td>
<td>Diversify Quarterly Report W1</td>
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<td>Top Shelf</td>
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<td>Market update details (to follow)</td>
<td>Click Done when finished</td>
<td>When Done return to 1/4.3</td>
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<tr>
<td>Library</td>
<td>1/4.3. 8</td>
<td>Market update details (to follow)</td>
<td>Click Done when finished</td>
<td>When Done return to 1/4.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2—User Checklist

USER CHARACTERISTICS CHECKLIST

1. Cognitive Characteristics:

• general aptitudes
• specific aptitudes
• functional literacy (e.g., reading level)
• visual literacy (e.g., ability to perceive graphics)
• computer literacy (e.g., ability to use WIMP interface)
• learning styles
• metacognitive abilities
• prerequisite content knowledge

2. Personality Characteristics:

• motivation to use this program
• motivation to learn
• interests
• attitudes toward content
• attitudes toward learning
• attitudes toward technology
• self-esteem
• anxiety
• beliefs
• locus of control

3. Social Characteristics:

• attitudes toward collaboration
• tendencies to cooperate or compete
• relationships with peers
• socioeconomic status
• attitudes toward authority
• racial or ethnic background
• culture
• career
• educational level
4. Physical Characteristics:

- visual abilities
- auditory abilities
- tactile abilities
- general health
- fatigue
- age
- sex
Appendix 3— Formative Evaluation

Principles of Financial Investment
Formative evaluation
Please answer the following questions

1. What happened?
   Could the process have been made more enjoyable;
   Could the program have been made easier to use;
   Would you like to use more of these programs;

2. How can we improve what we’re doing?
   In terms of interface design;
   In terms of interaction design;
   In terms of information design

3. What learning occurred?
   Could the concepts have been made easier to grasp;
   Could the students relate their learning to the real world;
   Could the material have been made easier to understand

4. Did the program make a difference?
   Could the material have been made more meaningful;
How did you find the blend of theory and practice
Principles of Financial Investment

Name

Formative evaluation

Please work your way through the program and note the following things:

1. Comprehension:
   Could the material have been made easier to understand;
   How did you feel about the amount of material covered;
   Was the material covered in enough depth

2. Interactivity:
   Was there enough interaction to keep the learner engaged;
   Were there enough elements of interest;
   Was navigation easy;
   Did you feel lost at any time

3. Appeal:
   How did you feel about the interface;
   Was the treatment of the material appealing

4. Attitude:
   Did you enjoy using the program;
   Did you want to return to the program;
   Did you feel as though you were actually trading shares
5. Learning:
   What did you think about the quantity of theory;
   Did you think that there were sufficient practical components to apply the theory;
Appendix 4—Useability Heuristics

Ten Useability Heuristics

Visibility of system status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Match between system and the real world

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

Recognition rather than recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

(Nielson, 1994).
Appendix 5—User Interface Rating

User Interface Rating Form

The "User Interface" of an interactive instructional product, e.g., a multimedia program, is a critical element of the product that must be carefully evaluated. If the user interface is not well-designed, learners will have little opportunity to learn from the program. This rating form includes ten major criteria for assessing the user interface for an interactive program, such as "ease of use" and "screen design." Not all of the criteria may be relevant to the particular program you are evaluating, but most of them will. You may need to add additional criteria to the list. Novice users of interactive instructional products are generally not good candidates for using this form. The people rating the user interface should be experienced users of the type of program you are asking them to rate. Even better, they could be experienced designers of interactive programs.

Instructions:

1. The "User Interface Rating Form" should be used by experienced interactive multimedia designers or users to rate the interface of a new program or one under development.

2. The ten criteria used in the "User Interface Rating Form" are explained in detail at the end of the instrument itself.

3. Some criteria may not be relevant in every IMM program.
Instructions: For each of ten user interface dimensions illustrated below, rate the program you have reviewed on a one to ten scale by circling the appropriate number under the dimension. (Accompanying this tool are definitions for each of the ten user interface dimensions.) Please add any comments that may help to clarify or explain your rating. If a specific dimension does not seem appropriate to the interactive program you are reviewing, do not circle any numbers on the scale for that dimension and add a brief comment to explain your response.

1. Ease of Use

<table>
<thead>
<tr>
<th>Difficult</th>
<th>Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

2. Navigation

<table>
<thead>
<tr>
<th>Difficult</th>
<th>Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

3. Cognitive Load

<table>
<thead>
<tr>
<th>Unmanageable</th>
<th>Manageable</th>
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</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
## 4. Mapping

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<tr>
<th>None</th>
<th>Powerful</th>
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<td>1</td>
<td>2</td>
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</table>

Comments:

## 5. Screen Design

<table>
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<tr>
<th>Violates Principles</th>
<th>Follows Principles</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Comments:

## 6. Knowledge Space Compatibility

<table>
<thead>
<tr>
<th>Incompatible</th>
<th>Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Comments:

## 7. Information Presentation

<table>
<thead>
<tr>
<th>Obtuse</th>
<th>Clear</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Comments:
8. Media Integration

Uncoordinated

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Coordinated

Comments:

9. Aesthetics

Displeasing

Pleasing

Comments:

10. Overall Functionality

Dysfunctional

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Functional

Comments:

Please add other comments related to the user interface of this program below:
Definitions for User Interface Rating Tool

User Interface Dimension 1 – Ease of Use

"Ease of Use" is concerned with the perceived facility with which a user interacts with an interactive multimedia program. Figure 1 illustrates a dimension of such a program ranging from the perception that the program is very difficult to use to one that is perceived as being very easy to use. Like many of the dimensions described in this tool, ease of use is both an aggregate and individual dimension. For example, in the aggregate sense, the Windows interface is generally perceived as easier to use than the command interface of the Microsoft disk operating system (MS DOS). However, in the individual sense, some people may perceive the MS-DOS interface to be easier to use because of their own unique experiences and attributes.

![Ease of Use Dimension](image)

Figure 1. "Ease of Use" dimension of user interface.

User interface dimensions may be highly correlated with how well users enjoy using a specific program. Whether users like a program may be more or less important, depending on the intent of the program and the context for its use. Certainly, not liking an interactive program that is intended to be highly motivating is a major problem, whereas users' affect for a program may be less important in a training context in which strong extrinsic motivational factors exist. Nonetheless, in the long run, improving the user interface dimensions of multimedia, such as "ease of use," is a highly desirable goal, regardless of context.

User Interface Dimension 2 – Navigation

"Navigation" is concerned with the perceived ability to move through the contents of an interactive program in an intentional manner. Figure 2 illustrates a dimension of interactive multimedia ranging from the perception that a program is difficult to navigate to one that is perceived as being easy to navigate. An important aspect of navigation is orientation, i.e., the degree to which a user feels that he/she knows where he/she is in a program and how to go to another part of it. This is a critical variable because users frequently complain of being lost in a interactive program (Utting & Yankelovitch, 1989). Designers use several ways of supporting navigation and maintaining orientation. A popular approach to navigation is the WIMP (window-icons-mouse-pointing) interface.

![Navigation Dimension](image)
Figure 2. "Navigation" dimension of user interface.

User Interface Dimension 3 – Cognitive Load

Using an interactive program requires different mental efforts than performing tasks via print or other media. In order to make any meaningful response to an interactive program, users must cope with and integrate at least three cognitive loads or demands, i.e., (a) the content of the program, (b) its structure, and (c) the response options available. To use interactive programs, users must perceive options, conceptualize a choice, and make some physical action, all while mentally coordinating the demands of these three cognitive loads. The user interface is the vehicle that allows perceptual, conceptual, and physical contacts with the interactive program. In terms of "cognitive load," the user interface can seem unmanageable (i.e., confusing) at one end of the continuum and easily manageable (i.e., intuitive) at the other end (see Figure 3).

![Cognitive Load Continuum](image)

Figure 3. "Cognitive Load" dimension of user interface.

Learners acquire and structure information delivered via interfaces, conduct mental operations, and accomplish physical activities during their interactions with interactive multimedia. The limited capacity of working memory to hold only five to nine chunks of information simultaneously makes it difficult for users of complexity structured programs to reason when numerous cognitive load factors must be handled simultaneously. Users may feel overwhelmed by numerous options that increase the cognitive load. The risks of confusion are especially high when users confront programs which by their very nature include many interactive options. The possibility of user disorientation is a major concern in the increasingly popular multimedia programs that feature a complex, flexible structure.

User Interface Dimension 4 – Mapping

"Mapping" refers to the program's ability to track and graphically represent to the user his or her path through the program. In complex, non-linear programs, user-disorientation can be alleviated if users can see what parts of the system they have already accessed. Utting and Yankelovitch (1989) discuss user disorientation as referring to, among other things, the user's not knowing "the boundaries of the information space." Having a detailed mapping system gives users an aid in understanding which parts and how much of the information space they have interacted with, and conversely which parts and how much of it they haven't. Interactive programs fall in a continuum of containing no mapping function to an appropriately powerful mapping function (see Figure 4).
The notion of an "appropriately powerful" mapping function requires some explanation. Just as it is important to possess a map of the most usable scale when taking a road trip, it is important for interactive programs to provide enough, but not too much, detail in showing user paths. A map that shows every piece of a program's knowledge space might prove to be so tedious or unwieldy as to be of as little value as an interactive program with no map.

**User Interface Dimension 5 - Screen Design**

"Screen Design" is a particularly complex dimension of interactive programs that can easily be broken down into many sub-dimensions related to text, icons, graphics, color, and other visual aspects of interactive programs. Shneiderman (1987) maintains that although certain design principles have been established, "screen design will always have elements of art and require invention" (p. 326). A separate dimension has been defined to deal with the artistic aspects of interactive programs (see Dimension 9 - Aesthetics below). We define "screen design" as a dimension ranging from substantial violations of principles of screen design to general adherence to principles of screen design (see Figure 5).

There are two problems with this dimension. First, screen design principles have not kept up with the rapidly changing nature of interactive technology. Second, creative designers may sometimes intentionally violate screen design principles for effect or to otherwise focus the user's attention. Nonetheless, we think that there exists enough knowledge about the principles of screen design that people, particularly experienced designers, can make meaningful distinctions among poorly and well designed screens in interactive programs.

**User Interface Dimension 6 - Knowledge Space Compatibility**

"Knowledge space" refers to the network of concepts and relationships that compose the mental schema a user possesses about a given phenomena, topic or process. Subject matter experts and/or designers of interactive programs are generally perceived as possessing an expert knowledge space with respect to the content included in the programs they create. This expertise usually is the basis for the structure of the knowledge or information presented in a program. Novice users, on the other hand, often possess an inadequate knowledge space with respect to the
content of a program. The knowledge space of novices may be inadequate because of ignorance, misconceptions, or some blending of ignorance and misconceptions. When a novice user initiates a search for information in an interactive program, the interface should be powerful enough so that the user perceives the resulting information as compatible with his or her current knowledge space (see Figure 6). If the information received is not perceived as relevant to the search strategies used by the user, the system will be perceived as incompatible.

Admittedly, this is a very difficult dimension to judge. However, if a user initiates a search for information about a topic, e.g., the procedures for installing new software, the resulting information should seem compatible with that search once the information is thoroughly explored. If the information seems arbitrary or irrelevant to the search that was initiated, the knowledge space representation should be judged as incompatible.
User Interface Dimension 7 – Information Presentation

The "Information Presentation" dimension is concerned with whether the information contained in the knowledge space of an interactive program is presented in an understandable form. The most elegantly designed user interface for an interactive program is useless if the information it is intended to present is incomprehensible to the user. Certainly the user might be able to find all of the information about a subject, but whether the user could then comprehend, understand, or learn that information is another matter. Imagine a complicated installation procedure presented in textual form, written in a stream of consciousness style reminiscent of James Joyce’s Ulysses. Or consider a video presentation on sales techniques for ATMs, directed and produced by Andy Warhol. In each case the information requisite for understanding may be present, but would probably be difficult if not impossible to comprehend. Information presentation is defined as a dimension ranging from obtuse to clear (see Figure 7).

![Information Presentation dimension of user interface.](image)

User Interface Dimension 8 – Media Integration

The most important aspect of the media integration dimension refers to how well an interactive program combines different media to produce an effective whole. Do the various media (text, graphics, audio, video, etc.) work together to form one cohesive program, or is the program a hodgepodge of gratuitous media segments? Are the various media components necessary to the function of the program or would the program function equally as well without them? The media integration dimension is defined as ranging from uncoordinated to coordinated (see Figure 8).

![Media Integration dimension of user interface.](image)

User Interface Dimension 9 – Aesthetics

"Aesthetics" refers to the artistic aspects of interactive programs in the sense of possessing beauty or elegance. In the aggregate sense, many people may praise the aesthetics of an automobile design or the elegance of a bridal gown. However, in an individual sense, aesthetics are highly unique and one person's sense of the beautiful may seem grotesque to another. Eisner (1985) described the need to develop "connoisseurs" in evaluation of education and training, just as we have connoisseurs in the arts. Connoisseurs have refined tastes and a deep sensitivity to
aesthetics that enable them to criticize phenomena (e.g., plays, paintings, musical scores, or interactive programs) in a manner that can be communicated to others. In turn, other people, perhaps less refined and less sensitive, may become more informed by "consuming" the expert reviews provided by the connoisseurs. In the absence of such connoisseurs, the aesthetics dimension of the user interface of an interactive multimedia program is defined as ranging from displeasing to pleasing (see Figure 9).

![Figure 9. "Aesthetics" dimension of user interface.](image-url)

**User Interface Dimension 10 – Overall Functionality**

"Overall Functionality" is an aspect of interactive multimedia programs related to the perceived utility of the program. The perceived functionality of an interactive program is obviously highly related to the intended use of the program. A given program may have multiple uses. Its overall functionality must be judged in relation to the specific intended use that exists in the mind of the users. Figure 10 illustrates a dimension of the user interface of interactive programs that ranges from dysfunctional to highly functional.

![Figure 10. "Overall Functionality" dimension of user interface.](image-url)
Appendix 6—Pre- and Post-Test

Name: ________________________________

Q1 Bank of Perth is offering their shareholders a dividend of 60 cents per share payable next year. Over the previous four years the dividend has grown on average 8% p.a. Currently shareholders in Bank of Bunbury are earning 15% p.a. Assuming that all the factors mentioned above remain constant and that you wish to purchase a share in Bank of Perth how much should you pay for this share?

Q2 You have been told by your stock broker that Noster, a communication giant in Australia is about to sell their shares and he/she is offering you the option to purchase these shares. The future dividends are expected to be as follows:
- Year 1- 50 cents
- Year 2- 55 cents
- Year 3- 60 cents
From year 4 the dividend is expected to grow by 2% p.a. forever. If your required rate of return is 10% p.a. what price should you pay for each share?

Q3 By Ltd is offering all shareholders a perpetual dividend of 20 cents per share. If your required rate of return is 8% p.a. and you wish to hold the share for 5 years then sell it what price should you pay for each share?

Q4 Quick Ltd will pay a dividend of 10 cents per share perpetually every 4 months. If your required rate of return is 20% pa. how much should you pay for each share?

Q5 Every year Stable Ltd have been paying their shareholders a dividend of 20 cents per share. But recently they announced a 4% growth in dividends with the intention of perpetually maintaining this growth rate. Currently their share price is $1.33. Determine the rate of return to a shareholder in Stable Ltd?
Q1. What is meant by the following terms?
   Discounted Cash Flow
   Net Present Value
   "ex-dividend date"
   insider trading
   underwriting

Q2. A media company has predicted that its shares will increase to a value of $9.45 four years from now. In the meantime the shares are expected to pay a dividend of $1.00 a year from today; $1.20 two years from today; $1.25 in three years time and $1.50 at the end of four years. An investor has a required rate of return of 20% pa. How much is each share worth to the investor and what is the Net Present Value today if he bought 2000 shares and paid $8.92 today for each share?

Q4. What is the present value of $400 promised three years from today if you can earn 20%p.a.

Q5. What technique is used to value shares?

Q6. If you are about to invest in shares how will you determine what rate of return you want from the share?

Q7. What is the difference between an Accumulation Index and a Share Price Index?

Q8. If the Media Share Price Index rose from 1563 to 1782 over three years what average annual rate of return did you receive and what does this index measure/represent?

Q9. A share promises to pay a $1.50 dividend one year from today and then the dividend will rise by 10% every year forever. How much is the share worth to an investor if their required rate of return is 18% p.a.?

Q10. What is the name of the computer share purchasing and selling system used by brokers?

Q11. Today you purchase 1000 shares at $1.73 each and sell them in exactly one year for $1.89. Given that your stockbroker charges you a fee of 1.5% on both purchases and sales of shares what return did you achieve?

Q12. When a company first issues its shares, for example Telsta,(this is called a float), what is the name of the document that all potential shareholders will receive from the company?

Q13. When a company announces a dividend what are the three most important pieces of information about that dividend?

Q14. You know how to determine the return from a share but do you know what formulae you use to measure its risk?

Q15. What is the formulae for determining the Price Earnings Ratio?

Q16. Consider the returns over the past three years for companies ABC and XYZ

<table>
<thead>
<tr>
<th>Year</th>
<th>ABC</th>
<th>XYZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>2</td>
<td>12%</td>
<td>7%</td>
</tr>
<tr>
<td>3</td>
<td>11%</td>
<td>8%</td>
</tr>
</tbody>
</table>

If you invested $100 in both ABC and XYZ( ie equal amounts of money) what return did you receive each year? Express your answer as a percentage rate of return.
Appendix 7—Program Instructions
Principles of Financial Investment
Microworld CD
Setting up your Computer

Installing the Software

1. Place the CD into the CD-ROM player
2. Go to "My Computer" icon, and double click the D drive (or CD drive) (now called Finance 1)
3. Four folders will appear, drag the Explorer, Quickt-1 and Shockw-1 folders onto your desktop
4. Double click the Explorer folder on the desktop and double click the icon inside it. Answer the questions. Explorer will be installed
5. Double click the Quicktime folder on the desktop. Double click the icon and respond to the question. Now close the box and reopen. Two icons will appear. Double click the "Qt32Inst" icon to install Quicktime
6. Double click the Shockwave folder on the desktop and the icon inside it
7. Now return to your CD drive and double click the Program folder
8. You will see an icon that looks like a projector with "Finance.exe" written underneath it. Double click this to launch the program.
The Program

You can click on the quit button at any time or use Ctrl Q. Don't forget to save your work.

Click on these doors to go inside the program and start investing your $100,000.

The save & retrieve machines allow you to save your work and retrieve your last position when you re-enter the program. You will need a disk in your A drive.
Reception Area

You need to register before you can start investing. Click on the register on the desk and type your name. Press Enter.

This floorplan shows you the various areas you can visit.

Click on the register to type in your name.

This area will also give you hints and tips if you are not sure where to start.

Click on the EXIT sign to go back to the street and save your work.
The Broker

The Broker's area contains information of the various stocks and also allows you to do your buying and selling.

Go through here to make buy/sell transactions

Click on the quarterly reports to get up-to-date information on each stock

These three reports give you information about the market generally.
The Buy/Sell screen
You must buy in blocks of 1,000 shares.

If you wish to sell, click in here and type a minus sign in front of the quantity, Press Enter.

Click in these boxes and type in the amount of shares you wish to buy. Press enter. Move to the next box with the mouse.
The Stock Exchange

Click here to visit the library to view quarterly reports

Click on the desk for hints and tips.

Click here to go to the Viewing Room
Click on Sean to view his investment progress.

Wonda looks happy because she applies the theory to her investment decisions. Click on her if you want to view her progress.

Price board giving prices per stock per quarter.

Stock Price Summary, Quarter 6
- Lion Oil: $1.20
- DNA Engineering: $0.30
- AudBank: $4.20
- Diversity: $8.50
- Castle Mining: $5.35
- Corp-Corp: $14.20
You can enrol in these three courses. The amount will be deducted from your account balance.

Click here for hints and tips

This is a free self-test
Once you have enrolled in a tutorial at the Institute, the material will be downloaded into the filing cabinet.

Click on the tv to view news updates and stock market reports.

Click on the clock to move to the next quarter and view share price movements.

When the telephone rings, click on it to hear market hints. NOTE you may also be exposed to ethical dilemmas!

Click here to view your investment portfolio.
Your Investment Portfolio

This is updated each quarter. To review previous trades click on the tabs.

Click on the tabs to review previous trading positions.

Click on EXIT to return to your office.
Appendix 8—Interview Questions
# Interview Questions

The following inventory is designed to get some background information in order to design interactive multimedia which best serves the needs of adult learners. The program you have just completed was specifically designed for students in introductory finance and we want to determine which parts work, which parts don’t and which parts need some fine tuning. Your responses in this interview are important and valuable, but if at any time you don’t want to participate, you can withdraw. Your responses will be taped as a backup system.

The first section seeks to get some understanding of your background:

<table>
<thead>
<tr>
<th>1. What is your age?</th>
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<tbody>
<tr>
<td>18-21</td>
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<tr>
<td>22-29</td>
</tr>
<tr>
<td>30-45</td>
</tr>
<tr>
<td>45 and over</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Sex:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. What is your highest level of education?</th>
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<tbody>
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<tr>
<td>Associate Diploma</td>
</tr>
<tr>
<td>Bachelor's Degree</td>
</tr>
<tr>
<td>Master's Degree</td>
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<table>
<thead>
<tr>
<th>4. How far through your course are you?</th>
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</thead>
<tbody>
<tr>
<td>In first year</td>
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<tr>
<td>In second year</td>
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<tr>
<td>In third year</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Have you studied Finance before?</th>
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</thead>
<tbody>
<tr>
<td>Yes</td>
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<tr>
<td>No</td>
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<table>
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<tr>
<th>6. Are you currently employed?</th>
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</thead>
<tbody>
<tr>
<td>Full time</td>
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<tr>
<td>Part time</td>
</tr>
<tr>
<td>No</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>7. What is your cultural background?</th>
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</thead>
<tbody>
<tr>
<td>Aboriginal, Torres Straits Islander</td>
</tr>
<tr>
<td>European</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Australian</td>
</tr>
<tr>
<td>Other, please specify</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>8. What was your learning style?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converger</td>
</tr>
<tr>
<td>Diverger</td>
</tr>
<tr>
<td>Assimilator</td>
</tr>
<tr>
<td>Accommodator</td>
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</table>
The purpose of the next few questions is to get your thoughts and feelings on the actual program.

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>7</strong></td>
<td>What did you feel when you were told you were going to use the program?</td>
</tr>
<tr>
<td><strong>8</strong></td>
<td>What did you feel after you had used the program?</td>
</tr>
<tr>
<td><strong>9</strong></td>
<td>When you started the program, what did you want to get from it?</td>
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<tr>
<td><strong>10</strong></td>
<td>Did you achieve your goal/s. If not, why not?</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>How would you feel if you were asked to use more programs like this?</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td>When you first used the program, how did you find your way around?</td>
</tr>
<tr>
<td><strong>13</strong></td>
<td>How did you feel about having to find your own way round the program?</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td>Did you ever feel lost?</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>What were the strengths of the program?</td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>What were the weaknesses of the program?</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td>What would you like changed or added?</td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>With the benefit of hindsight, how would you approach using the program if you were starting afresh?</td>
</tr>
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</table>
This next section asks more specific questions about the program

<table>
<thead>
<tr>
<th>Immersion</th>
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<td>21</td>
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<thead>
<tr>
<th>Reflection</th>
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<table>
<thead>
<tr>
<th>Flow/Feelings</th>
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<tbody>
<tr>
<td>30</td>
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<td>31</td>
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<thead>
<tr>
<th>Collaboration</th>
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<tbody>
<tr>
<td>32</td>
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<td>33</td>
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<tr>
<td>34</td>
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<td>35</td>
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| Learner Control |
| 36 | How did you feel about working at your own pace? |
| 37 | How did you feel about choosing where to go in the program? |
| 38 | How did you feel about having hints and tips available when you wanted them? |
| 39 | How did you feel about the level of hints and tips dropping as you worked through the program? |
| 40 | Curiosity |
| 41 | Were you keen to see what happened next? |
| 42 | How did you feel about having surprise elements in the program? |
| 43 | Fantasy |
| 44 | How did you feel about stretching the limits of your experience? |
| 45 | How did you feel about being able to forecast share prices? |
| 46 | Challenge |
| 47 | What did you feel about the level of difficulty of the program? |
| 48 | How did you feel about being able to learn from the experts and apply that learning? |
| 49 | How did you feel about applying what you learned from the on-line tutorials? |
| 50 | How did you feel about being able to buy the tutorials on-line? |
| 51 | Did you find the program challenging? |
| 52 | Did you find the program motivating? |
| 53 | If not, why? |
| 54 | If not, why? |
| 55 | Do you have any other thoughts or feelings about using this package? |
| 56 | What advice would you give to a student deciding whether to complete the package? |
| 57 | Would you like to complete more packages of this nature? |
Appendix Nine

Description of terms used in this study

The following list gives an overview of the terms used in this study and a description of their meanings. This list is by no means comprehensive, but is intended to give a reader, who may be new to instructional design, an insight into the way in which the terms are used in this context.

**Acrostics** are a series of lines in which the first or last letters form a word or a phrase.

**Agon** is a class of game which is competitive enabling the players to lift their performance.

**Agon** means games that are competitive.

**Alea** are games of chance.

**Alea** is a game of chance, encouraging the player to forecast what will happen.

**Anchored instruction** provides the means for recreating everyday experiences in an educational setting.

**Andragogy** is the art and science of helping adults learn (Knowles, 1980).

**Authentic activity** is an activity which reflects the way the knowledge will be used in real life (Herrington & Oliver, 1995).

**Authentic assessment** is assessment that has a meaningful context and relates to authentic concerns and problems faced by students.

**Autotelic** activities are an integration of work and leisure activities. They are so enjoyable as to be indistinguishable from each other.

**Cognitive apprenticeship** is a general framework with four components—content, methods, sequences and social aspects (Brown, 1989a).

**Cognitive load** is the amount of information that can be held in short term memory at any time.

**Flow** is a state of total immersion, when self-consciousness and time disappear. People will undertake flow activities for their own sake rather than any reward (Csikszentmihalyi, 1992).

**Ilinx** are games that alter consciousness by scrambling perception.

**Immersion** is a form of focussed attention, where the outside world ceases to exist.

**Individual differences** influence how the learner filters instruction and either allows or inhibits the assimilation of information (Jonassen & Grabowski, 1993).

**Instructional landscape** is another term for instructional multimedia. Elements of instructional landscapes are their interactivity and degree of learner control, and their entertainment, experiential and motivational features.

**Interactive multimedia** is an electronic program in which the user is a participant in the activity rather than a passive observer (Morrison & Morrison, 1994).

**Interactivity** is determined when the learners feel themselves to be participating in the activity—in other words, when the senses are engaged in the action.

**Interface design** is the means by which designers can improve the way people use computers to think, communicate, observe, decide, calculate and simulate. Improving the way people accomplish their tasks (Rheingold, 1990).
Learning styles are the ability to process information, construct meaning from it and apply it to new situations (Jonassen & Grabowski, 1993).

A Microworld is a program simulating a small part of a real environment through which content can be woven, allowing the student to explore and discover context specific information.

Mimicry are games in which alternative realities are created.

Mimicry is a game in which alternative realities are created, enabling the players to role-model situations or roles without threatening their reality.

Multimedia encompasses a range of data types, animation, audio, hyperlinks and digital ink. It also includes delivery media (eg CD-ROM) and graphics display hardware and sound cards (Reinhart, 1995).

Situated cognition is giving students a relevant context in which to learn, a means of learning while doing.

Valence is the worth or value of an activity.
Appendix 10

Statement of Disclosure and Informed Consent

You have been invited/nominated to participate in this study which is part of a higher degree research study. The purpose of the study is to investigate the effects of a program called Principles of Financial Investment has on students.

You will be asked to complete the program and to complete a learning styles inventory, a course interest survey and a pre-, post- and delayed post-test. You will also be asked to be interviewed to get your opinions about issues to do with the program itself.

You may also be videotaped using the program so that the researcher may see where you go in the program. Your voice and the voice of anyone you speak to will also be recorded, but the only items of interest to the researcher are those to do with the way you interact with the program. At no time are you or your performance to be assessed for any other purpose, and there are no right or wrong ways of completing the program.

You will only be identified by the name you have chosen to give me in the writing up of the study, and you should not experience any stress-related problems or discomfort when you are using the program. The overall aim is that you enjoy the experience of using the program.

Although this study has potential long-term benefits for future students, you may choose to withdraw at any time from the program or any of the survey instruments and you will in no way be penalised either now or in the future for any of your actions.

If at any time you have any concerns, worries or comments about the program or the research process, please do not hesitate to contact me:

Sue Stoney (Principal Investigator), Management Information Systems, on 0417 832 322, or Dr Ron Oliver on 9370 6372.

Please sign both copies of this form, one is for you to keep for your records, and one is for mine:

I __________________ have read the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

Participant ___________________________ Date

Investigator ___________________________ Date
Appendix 11

The following list are some of the refereed and non-refereed articles and presentations emanating from this research. Please note that some of the earlier work was completed in the researcher’s previous name of Wynn.

Refereed Articles


Stoney, S., & Oliver, R. (1997). Making interactive multimedia appealing to adult learners. In T. Muldner & T. Reeves (Eds.), *ED-MEDIA97 and ED-TELECOM 97*. Calgary Alberta, Canada: Association for the Advancement of Computing in Education. (Earned a Best Paper Award)


Non-Refereed Articles


Presentations

