Validating A Theory-Based Design For Online Instruction:
The Integrated Learning Model

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DEDICATION

This dissertation is dedicated to my wife, Freda, who made it happen.

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ABSTRACT

The goal of this study is to present the empirical results of a design experiment that validates the Integrated Learning Model (ILM). The study also explores the contribution of multiple Web-tools that facilitate specific learning outcomes.

Using a multiple paradigmatic approach that blends the best of both cognitive and situative perspectives in an open-learning constructivist environment, three broad constructs were used to identify variables that influence learning. These constructs include (1) *knowledge acquisition strategies* (2) cognitive tools that support *practice* and (3) *assessment components* that capture artifacts of learning

In addition, the ILM uses expertise, pedagogical content knowledge and self-regulation as principles that anchor instructional designs. While these principles have traditionally been operationalized separately in classroom settings, they have not been implemented simultaneously to constitute the core elements of an open-learning model. The ILM represents such a synthesis.

Data were collected from 338 students using various tools online, as well as from four surveys administered throughout the semester. Sixty percent of the participants were male with an average age of 21 years. They spent approximately six hours per week on the course. Print material, interactive practice tests and online information were the most frequently used tools. Other tools such as videos and communication software were also positively rated. The majority preferred a mixture of discovery learning and guided instruction. From the fifteen online items, three extracted factors explained 69% of the total variance and loadings were above the 0.7 threshold. These factors correspond to the three broad constructs identified above. Given these dimensions and the latent construct (learning), Structural Equation Modeling techniques were applied to confirm the ILM.

The ILM is introduced to encourage designers of Web-based instruction to engineer appropriate knowledge acquisition strategies and to practice opportunities and appropriate assessment methods that are theoretically driven and constructively aligned in an open learning environment. Such Web-designs open new doors to faculty,

administrators, employers, and learners. They help to explain why participants learn meaningfully and what might enable them to create knowledge.

RÉSUMÉ

La présente étude a pour objet de donner les résultats empiriques d'un protocole expérimental qui valide le modèle d'apprentissage intégré (MAI). Elle explore aussi la contribution respective des multiples outils du Web à la facilitation d'un apprentissage spécifique.

Dans le cadre d'une approche paradigmatique multiple alliant les meilleurs éléments des perspectives cognitives et de mise en situation dans un environnement constructiviste d'apprentissage ouvert, trois vastes constructs ont été utilisés pour identifier les variables qui influent sur l'apprentissage : (a) *stratégies d'acquisition des connaissances,* (b) outils cognitifs à l'appui de la *pratique* et (c) *éléments d'évaluation* pour l'acquisition des objets d'apprentissage.

Le MAI utilise l'expertise, la connaissance du contenu pédagogique et l'autorégulation comme principes ancreurs des modèles pédagogiques. Ces principes, opérationalisés séparément dans des environnements de salle de cours, n'ont jamais été appliqués ensemble pour constituer les éléments fondamentaux d'un modèle d'apprentissage ouvert. Le MAI représente une telle synthèse.

Des données ont été recueillies auprès de 338 étudiants au moyen d'outils en ligne et de quatre sondages administrés pendant le semestre. Les participants, des hommes dans une proportion de 60 % et d'un âge moyen de 21 ans, ont consacré environ 6 heures par semaine au cours. Les documents imprimés, les tests interactifs et la communication d'information en ligne ont été les outils privilégiés. D'autres outils (vidéos et logiciels de communication) ont aussi obtenu une évaluation positive. La majorité des participants a préféré un mélange d'apprentissage par exploration et de cours dirigé. Parmi les 15 éléments en ligne, trois facteurs, qui correspondent aux trois constructs ci-dessus, ont expliqué que 69 % des variables saturées et de la variance totale étaient au-dessus du seuil de 0,7. Compte tenu de ces dimensions et du construct latent (apprentissage), des techniques de modélisation des équations structurelles ont été appliquées pour confirmer le MAI.

Le MAI est conçu pour inciter les concepteurs de modèles éducatifs basés sur le Web à élaborer des stratégies d'acquisition des connaissances et à offrir des possibilités et des méthodes d'évaluation axées sur le plan théorique et alignées, de par leur

construction, sur un environnement d'apprentissage ouvert. De tels modèles Web ouvrent de nouvelles portes aux facultés, aux administrateurs, aux employés et aux apprenants. Ils aident à expliquer pourquoi les participants reçoivent un mode d'apprentissage valable, qui pourra les amener à acquérir les connaissances.

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CHAPTER 1
INTRODUCTION

Web-based instruction based on accepted theoretical principles in instructional and cognitive psychology opens new doors to designers, learners and practitioners. However, we still know very little about theory-based designs that result in best practices and that use primarily this medium. Numerous studies have explored the learning effects of using multimedia, hypermedia, and technology-enriched courseware, but they have been mainly criticized on methodological grounds, as well as for their lack of scope (see Clark, 1983, 1994; Clark and Estes, 1999; Dillon and Gabbard, 1998; Dreyfus, 1992; Ehrmann, 1995; Kozma, 1994; Kulik and Kulik, 1991; Newson, 1994; Taylor, 1997; Williams and Taylor, 1998). Conflicting findings have been documented in *The No Significant Difference Phenomenon* (Russell, 1999), which was based on 355 research reports, summaries and papers. Many of these report no significant difference between technology-enriched and conventional classroom instruction but often times they make apple/orange comparisons and they use myopic research designs.

According to Clark and Estes (1999) “the main source of concern for most observers of our field is a persistent irrelevance in our enquiry and practice.” Reeves (1995; 2000) found that most studies in instructional technology are “riddled with problems such as specification error, lack of linkage to theoretical foundations, inadequate literature reviews, poor treatment implementation, major measurement flaws, inconsequential learning outcomes for research participants, inadequate sample sizes, inaccurate statistical analysis, and meaningless discussions of results” (p. 4). Merisotis and Phipps (1999) identify several shortcomings of prior research and gaps in the literature. They question the validity and reliability of instruments used to measure student outcomes and point to the absence of studies that focus on the interaction of multiple technologies. They also point out that the research does not take into account differences between the learners, and that it does not include a theoretical or conceptual framework that would encourage further enquiry.

Despite these findings, many colleges and universities are allocating substantial resources towards the development of distance education courses and programs (Brahler, Peterson, and Johnson, 1999). The expectation is that there will be an increase in learning, while the quality of education will be damaged little, if at all (Ehrmann, 1999). According to new data from *The 1999 Campus Computing Project*, faculty attempting to "integrate information technology into instruction" remains the single most important information technology issue confronting colleges and universities over the next two to three years (Green, 1999). At the same time, there remains considerable resistance to the development of technology-based distributed learning environments (Rickard, 1999). Questions and concerns relating to technology integration are being raised, but as yet have had little systematic impact on the policies that guide educators, administrators and practitioners (Merisotis and Phipps, 1999; Reigeluth, 1999; Welte, 1997).

Responding to these challenges, Cross (1998) has suggested that the time is ripe for "communities of practitioners to generate relevant knowledge about the practice of their profession" that bridges both cognitive and social perspectives in educational reasearch. Cross echoes what Donald Schon suggested a decade earlier, namely that practitioners should engage in a search for knowledge by asking themselves "what kinds of knowing are already embedded in competent practice?" (Schon, 1983, p.29). Similarly, in his 1999 AERA Presidential Address, Alan Schoenfeld described the split between cognitive and social science research. He was referring to several studies in cognition that excel in fine-grained data analysis but suffer from tunnel vision. On the other hand, many sociological studies are rich in scope but are weak with respect to validity and reliability constructs. His suggestion to bridge the gap was to "build something to see if it works and then study the hell out of it" (Schoenfeld, 1999).

Clark and Estes (1999) call for the development of authentic technology based firmly on scientific work. "Authentic technology" is defined as "an educational solution resulting from systematic analysis that identifies the problem being solved, selects and translates appropriate, well-designed research, and applies it to design culturally appropriate educational solutions" (p. 6). Similarly, Reeves (2000) suggests that a new generation of researchers should be encouraged to engage in developmental research that requires "a pragmatic epistemology that regards learning theory as being collaboratively shaped by researchers and practitioners" (p.12).

The present study presents a theory-based design of an undergraduate web-based course in Personal Finance. It is the author's belief that this will open new doors to designers, practitioners and researchers in the field. The aim is to address some of the issues above in the context of better understanding student learning via a technology-enriched platform. Concerns relating to technology integration in educational practice, and technology's intersection with learning theory are explored in a design framework that aligns learning objectives, course activities, and assessment methods. This alignment also identifies cognitive online learning tools that mediate between design components for the web-based course in Personal Finance. The selection of learning tools is also important insofar as these tools affect student performance and will be meaningfully used by them.

The study is based on development goals that build upon non-traditional designs and theoretical findings from the cognitive and social sciences literature. The research strategy reflects what Ann Brown originally described as "design experiments" (Brown, 1992) and what other educational experts have labeled as "formative research" (Neuman, 1990); "development research" (Akker, 1999); and "use-inspired research" (Stokes, 1997; Reeves, 2000).

Data gathered from the Personal Finance course addresses aspects of course design and learner characteristics that appear to support student performance in the course. Combining the web platform and a theoretical basis in a prototype course design becomes more meaningful if the prototype aims to accomplish specific learning goals and if there is evidence to link these goals with outcomes and performances that are assessed. These links are critically explored and are the major focus of this study. Observing what develops, in what ways and under what circumstances, studying the design's impact on what students actually learn, and validating a theory-based model of student learning constitutes the rationale behind this study.

Given the lack of empirical evidence resulting from monitoring the impact of theoretically robust web designs on student performance, this study makes a contribution by (a) conceptualising a web-based design model, (b) designing and implementing it, (c) validating its latent structure, and (d) providing evidence of design elements that are associated with student performance. It also provides the foundation for further enquiry in our understanding how technology based instruction impacts on student learning.

Research Objectives

Given the small number of design theories and the lack of empirical results of technology-rich Web-based learning environments, the specific research objectives of this study include:

1. To identify an integrated model of learning for a web-based course.
2. To test for the influence of variables identified in the literature that can potentially have a significant impact on learning.
3. To identify and profile characteristics of an on-line learner.
4. To present results from various surveys and evaluations conducted for the course.
5. To discuss the implications of results in order to offer guidelines for Web-based instructional models and to promote further enquiry in this area.

The following chapter presents a review of the literature as it relates to the objectives of this study, including research on three distinct but overlapping areas of enquiry: (a) an exploration of different views on how individuals learn, (b) a review of instructional computer based systems, and (c) a review of on-line learning technologies and theory-based design configurations on the World Wide Web (WWW).

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

This chapter is divided into three main sections. The first section explores different views of how individuals learn. Although there are important distinctions between theories of learning, which tend to be descriptive, and theories of instruction, which tend to be applied to educational problems, they are also closely related. The different sections present a review of theories of learning and instruction simultaneously. These views are categorized under knowledge acquisition and knowledge construction. Situated cognition, a more recent theoretical perspective which emphasizes social and ecological interaction as a basis for knowledge, is also discussed. The purpose of presenting these views is to locate ways in which they influence instructional design practices.

Based on these knowledge constructs, three widely used concepts in cognition and instruction are explored to shed further insight into the complex nature of learning. These include expertise, pedagogical content knowledge, and self-regulation. Although each of these looks at different aspects of teaching and learning, there are important implications for designing instruction as well. This section also integrates these concepts as they affect instructional design and educational practice.

The second section begins with a definition of technology and a brief historical overview of the efforts made to integrate technology in instruction. This is followed by an extensive review of the literature on computer-based learning environments. This review provides insight into the evolution of current interactive on-line learning technologies being used on the Internet and the World Wide Web (WWW).[1]

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[1] **Internet**: Originally called ARPANET after the Advanced Research Projects Agency of the U.S. Department of Defense. The electronic connection began in 1969 as a government experiment with four computers connected together over phone lines. The internet connects the hosts so that you may go from one web page to another efficiently. **The World Wide Web:** A multimedia database of information on the Internet. It is a universal mass of web pages connected together through links. The WWW consists of server software designed to distribute documents stored in a location over the Internet as well as client software (such as Netscape, Mosaic, etc.) that enable the end user to browse, retrieve, and post documents which are stored on one or more servers.

The third section reviews on-line learning technologies and different design configurations on the WWW to discern best practices of theory-based designs. Given the wide scope of research in the domain of information technology, computer-mediated communication, distance education and distributed learning, and considering the huge increase in multimedia and technology-rich courseware, selective studies and approaches are reviewed. This last section concludes with a summary of pedagogical and managerial issues that designers should consider when seeking to integrate technology and thereby enrich student-learning experiences on the WWW.

Section I: Knowledge Paradigms and Key Cognitive Concepts

Paradigm shifts in designed instruction occurred at the turn of the century under the rubric of behaviorism (Cooper, 1993). Behaviorists asserted that human thinking could be completely understood in terms of external behavior. They based their belief largely on the study of animal learning in artificial laboratory settings. Results of stimulus-response patterns and reinforcements were used to define human learning theories of operant conditioning. The designer's role was to create "teaching machines" that were driven by behavioral objectives and programmed instruction and that provided immediate feedback in terms of rewards and punishments (Pressey, 1927, 1964; Skinner, 1954; Thorndike, 1912). Skinnerian approaches used technology as a means of emphasizing learning efficiency gains. Educational practice was consistent with what is often associated with a transmission model of instruction. In this model, learning involves the accumulation of facts and skills dispensed by an expert, who then accounts for facts and skills.

In contrast to behavioristic instructional approaches that were based on learning as response strengthening, Mayer (1992) describes how two different views of learning have emerged during the past 100 years; (a) learning as knowledge acquisition, and (b) learning as knowledge construction. The epistemological question elicited by the first view is whether learners discover knowledge that exists "out there" in reality; the second view asks whether learners construct knowledge for themselves through a process of language, thought, and social interaction.

Behaviorism fell out of favour and the general tendency of contemporary instructional thinking follows the tenets of either (a) or (b) above. The following sections explore these paradigmatic views.

Knowledge Acquisition

The knowledge acquisition perspective manifests itself in information processing views that focus on mental models of the learner. Learning environments generally reflect the representation of expert knowledge and symbolic reasoning. The key emphasis is on propositional networks and schema, where prescriptive (instructional) strategies are directed at promoting accurate knowledge acquisition by the learner (Anderson, 1983; Gallagher, 1979). Wittrock, (1979) summarizes this cognitive approach:

> The art of instruction begins with an understanding and a diagnosis of the cognitive and affective processes and aptitude of the learners. From these one designs different treatments for different students in different situations to actively induce mental elaborations that related previous learning and schemata to stimuli. In this conception the learners are active, responsible, and accountable for their role in generative learning. (p. 6)

An information processing view typically emphasizes course content that hierarchically structures the sequence of information. This sequencing might be based on Bloom's (1956) taxonomy of learning. This classic taxonomy includes six hierarchial classifications of learning: (a) *Knowledge*: eg. define, memorize, recognize, recall, etc., (b) *Comprehension*: classify, explain, report, review, etc., (c) *Application*: demonstrate, interpret, practice, solve, etc., (d) *Analysis*: appraise, calculate, discriminate, question, etc., (e) *Synthesis*: compose, create, design, manage, etc., and (f) *Evaluation*: argue, assess, predict, value etc.

Authoring programs and course management systems like Authorware and Dreamweaver (http://www.macromedia.com/learning/), Blackboard (http://blackboard.com/), WebCT (http://www.webct.com/webct/), etc., are considered appropriate to control the structure and sequencing of course content. In addition, feedback opportunities would typically be provided by an expert to ensure accurate knowledge acquisition. Finally, communication strategies would be designed to facilitate elaboration of content and solicitation of responses that reflect what students are thinking. Common tools employed in a web-based environment would include interactive tests, e-mail and bulletin boards, and video conferencing.

Examples of excellent strategies to promote knowledge acquisition abound. Many of these strategies can be easily adapted to the Web. While many can be identified as conventional teaching strategies, some are geared towards knowledge acquisition. For example, roles are assigned to participants to start discussions, to provide feedback and to wrap the discussions up. The jigsaw method is used to divide up reading material that is summarized and disseminated in groups. Field observation reactions and structured controversy is used to debate hot topics. Cases are employed to promote argumentation. Brainstorming ideas are encouraged and rated. Guest speakers and symposia are held, and the list goes on (Anderson, Corbett, Koedinger, and Pelletier, 1995; Bonk and Cummings, 1998; Bonk, Kirkley, Hara, and Dennen, 2000; Lajoie et al., 1995; Cognition and Technology Group at Vanderbilt, 1996; Vye et al., 1998.)

Knowledge Construction

Instead of knowledge being received , accumulated and stored, the knowledge construction view relocates cognitive functioning within its social, cultural and historical contexts so that learning occurs through experiences that facilitate knowledge construction. Jonassen, Davidson, Collins, Campbell, and Haag (1995) summarize this approach:

> learning is necessarily a social dialogical process in which the communities of practitioners socially negotiate the meaning of phenomena (p. 9)

Instructional designs that create constructivist environments engage learners in drawing meaning from multiple perspectives and through collaborative efforts. Engagement in real world or authentic tasks provides a context for the learner to construct meaning from his/her experiences. Thus, learning is situated within a community of learners who construct personal meaning through dialogue and socialization. For seminal writings in this area, see Brown, Collins, and Duguid, 1989; Duffy and Jonassen, 1992; Cobb, 1994; Haral and Papert, 1991; Jonassen, 1991, 1999; Jonassen and Reeves, 1996; Spiro, Feltovich, Jacobson, and Coulson, 1991; Wilson, 1995.

In this paradigm of knowledge construction, it is critical that the instructional designer not only understand the epistemology underlying these views in order to locate where the designer's pedagogical beliefs lie, but also to understand the implications of these views on the course design.

A constructivist view would present authentic problem solving opportunities where learners jointly construct knowledge and meaning based on multiple perspectives, discussion, and reflection. The role of the instructor might scaffold, facilitate, and guide learners as they learn to socialize and actively participate in issues considered important in the discipline. The group dynamic might represent one aspect of the socialization process, where novices and experts struggle to negotiate meaning through dialogical exchanges. Where the medium of instruction includes online resources and if multimedia is considered, common tools employed would include communication software, listserves, authentic cases in print, audio or video materials, interactive web exercises, simulations, etc. For notable examples of a design based on principles of knowledge construction, see The Cognition and Technology Group at Vanderbilt (1992), and Vye and Cognition and Technology Group at Vanderbilt, (1998).

Building on aspects of knowledge acquisition and constructivist approaches and borrowing from social, cultural and ecological theories, a more recent perspective on knowledge falls under the rubric of situated cognition. This theoretical view locates knowledge within the activity, context and culture in which it is used.

Situated Cognition

According to Resnick (1996), situated cognition refers to a loose collection of theories and perspectives that propose a contextualized, particularist, and social view of the nature of thinking and learning. In reacting to the rationalistic outlook of information processing theories, the situative perspective takes the theory of social and ecological interaction (not individual cognition) as its basis and develops increasingly detailed analyses of informational structures in the contents of people's information structures (Greeno, 1997). Greeno traces the concepts of situativity to involve properties of social practices that are studied mainly with methods and conceptual frameworks of ethnography, ethnomethodology, discourse analysis, symbolic interactionism, and sociocultural psychology. Other theorists have also suggested that situated cognition can be traced historically in the works of Dewey (1904/1965, 1933); Bartlett (1932); Gibson (1979/1986); Lewin (1936, 1946); Mead (1934); Vygotsky (1978).

In the influential article by (Brown et al., 1989), the model of situated cognition assumes that knowledge is contextually situated and fundamentally influenced by the activity, context, and culture in which it is used. Likewise, the most widely discussed cognitive apprenticeship model and its four major components (domain knowledge, teaching methods, sequencing, and sociology) interpret situated learning and the culture of expert practice as the process of learning by doing. In this spirit, Moore (1994) suggests that "the structure of school activity be reconsidered in light of the information gained in the analysis of non-school activities . . . to allow students to utilize the abilities they manifest in other activities" (p. 29)

Thus, situated cognition proposes a different location for knowledge and a different philosophy of knowledge in the learning process. Rather than isolating learning within the mind of the individual, learning is the result of many social interactions that take place within a framework of participation. Increasing participation in "communities of practice" has the effect of engaging the whole person, focussing on "ways in which it [learning] is an evolving, continuously renewed set of relations" (Lave and Wenger, 1991).

The following sections explore three widely used concepts in cognition and instruction that provide further insight into its complex nature. Expertise, pedagogical content knowledge, and self-regulation were selected because they are regarded in the education literature as important developments that help us to better understand the interplay between teaching and learning. These concepts also tend to impact qualitatively on instructional designs that are by nature recursive. Meaningful evidence gathered from teaching practice feeds into theory, which once again shapes various components of design – the entire cycle helping us to better understand different aspects of student learning. Thus, theories and concepts tend to influence design, which in turn is reflected in teaching practice.

Expertise

The organization of experts' knowledge has been researched by examining memory performance, pattern recognition, representation of problems, and the adaptive use of procedures in solving problems in the respective domain (Zeitz and Glaser, 1996). Initiated by the work of Simon on learning by doing (Anzai and Simon, 1979; Bhaskar and Simon, 1977), the focus on expert performance is to represent domain-specific structured knowledge. Studies on expertise have followed three steps: (a) identifying experts who demonstrate outstanding performance in a criterion task; (b) analyzing how they perform in comparison with novices; and (c) proposing learning mechanisms for their performance (Hatano, 1996).

Chi, Glaser, and Farr (1988) summarize generalizable findings and point to broad agreement among the research community on expert behavior. Their findings show that (a) experts chunk information as structured, principled knowledge; (b) experts' knowledge becomes proceduralized, or compiled in a condition-action form (Anderson, 1983); (c) experts' encoding processes circumvent the usual limits of short-term memory (Chase and Ericsson, 1982); (d) experts develop "automaticity" through repeated practice, so that conscious processing capacity is available for meaning and reflective thought; (e) experts' problem representation is more effective and tends to employ forward reasoning by integrating the information they receive (Patel and Groen, 1991); and (f) experts develop a set of strong self-regulatory skills which control their performance as they learn to monitor their problem solving ability (Larkin, McDermott, and Simon, 1980).

The epistemological principles underlying the majority of studies in expertise rely on the human information processing approach, which attempts to explain exceptional performance in terms of knowledge and skills acquired through experience (Ericsson, 1996). The computational view hypothesizes that the scientist's model and the subject's knowledge are equivalent in both notation and architecture. "Knowing" consists in large part in representing symbolically facts about the world (Newell and Simon, 1972).

The notion that expertise can be learned has important implications for teaching and learning. The pedagogical repercussions for cultivating expertise have been outlined by Zeitz and Glaser (1996), to include the following three aspects: (a) Knowledge scaffolding - a meaningful framework in which new information such as an explanation of a key aspect of expert domain knowledge is added that forms a coherent, fleshed-out structure unlike the traditional arrangement based on decomposition; (b) Knowledge development through conditions of effective practice, where guided and deliberate practice on certain aspects of performance not only improves competence, but can also free up cognitive resources for higher-level processes; (c) Creative assessment, where opportunities are provided for the learner to practice, develop arguments, reason, and demonstrate understanding.

Pedagogical Content Knowledge

The second concept selected is commonly known as pedagogical content knowledge and was coined by Shulman (1986) in conceptualizing a perspective on teacher knowledge, which he defines as "the particular form of content knowledge that embodies the aspects of content most germane to its teachability" (p. 9). According to Shulman, pedagogical content knowledge includes the most powerful analogies, illustrations, examples, explanations and demonstrations - ways of representing and formulating the subject that make it comprehensible to others, some of which are derived from research, whereas others originate in the wisdom of practice. It includes an understanding of what makes the learning of specific topics easy or difficult and deep knowledge about how to teach (Berliner, 1986). Also, pedagogical content knowledge has been distinguished from content knowledge, which includes an understanding of subject matter and its underlying organizational structures, and curricular knowledge, which includes the full range of programs designed for teaching subjects in particular circumstances. Thus, pedagogical content knowledge is a distinct category of teacher knowledge that includes the command of a particular content (alternative representations) and a particular process (pedagogical reasoning).

Self-Regulation

The third concept, self-regulation, can be defined as the ability to behave according to one's own intentions in a flexible way (Kuhl and Kraska, 1996). According to Butler and Winne (1995), self-regulation constitutes a series of episodes that can be characterized by a recursive flow of information, which is depicted in a processing model. This model is further refined by Winne (1997), who explains the profile of learner goals coupled with motivational beliefs and affective reactions that lead to strategic monitoring of discrepancies to shape self-regulation.

As regards academic learning, *self-regulation of behavior* involves the active control of the various materials and resources students have available to them, such as their time, their study environment, and their use of other individuals such as peers and faculty members. *Self-regulation of motivation* involves controlling and changing motivational beliefs such as efficacy and goal orientation, so that students can adapt to the demands of a course. Finally, *self-regulation of cognition* involves the control of various cognitive strategies for learning, such as the use of deep processing strategies that result in better learning and performance (Pintrich, Cross, Kozma, and McKeachie, 1986; Pintrich, 1995). In this way, self-regulation bridges the gap between performance and its determinants, and cognitive abilities and achievement, as learners adapt their approaches to learning.

Schunk and Zimmerman (1994) credit self-regulated learning as a key factor of success in learning, problem solving, transfer, and academic success in general. Similarly, cognitive self control is the cornerstone of Vygotsky's (1978) theoretical system, which emphasizes the character of effective instruction based on his much discussed "zone of proximal development":

> Initially, the learner may need assistance from his dialogue with the teacher to solve certain problems. This, in turn, will probably enable him to regulate this kind of problem-solving on his own, without need for any dialogical scaffolding (p. 313)

In Vygotsky's (1978) words "what is the zone of proximal development today will be the actual developmental level tomorrow - that is, what a child can do with assistance today she will be able to do by herself tomorrow." (p. 87)

Integrating Conceptual Relationships

The sheer breadth of each of the concepts discussed above results in several common characteristics. However, the nature of the relationships among these will depend partly on which lens is used to frame the concepts. For example, from an expertise perspective, learners develop a set of strong self-regulatory skills which control their performances. From a self-regulation perspective, learning is a problem-solving (expert) production system in which the problem is to reach the goal and the monitoring function involves steps to check whether the learner is making progress towards reaching the goal. However, a self-regulation perspective frames the environmental element by drawing on social cognitive theories such as Bandura's (1986) notion of triadic reciprocality, which combines the mutual influence of personal, behavioral, and environmental elements.

According to Sternberg and Horvath (1995) in their notable article "A prototype view of expert teaching", pedagogical content knowledge is the critical component for knowledge expertise: expertise in formulating and evaluating questions, problems, conjectures, conclusions, examples, evidence, explanations and arguments, and expertise in understanding and representing subject matter. Again, elements of pedagogical content knowledge can also be considered suitable in defining accounts of learning in terms of social participation and individual identities supporting such practices. For example, Greeno (1997) uses pedagogical content knowledge elements in the context of situated cognition, which he summarizes as "discourse that includes formulating and evaluating questions and problems, as well as solutions and conclusions, and proposing and criticizing explanations, arguments, and examples is crucial to meaningful participation in the activities of our society" (p. 15). From the situated cognition perspective, the learner is in direct contact with his environment (Orey and Nelson, 1994) and knowing is inherent in his actions. This perspective is reflected in the work of Schon (1983) who suggests that "practitioners employ reflection-in-action to construct new ways of framing problems so that situated action can resume."

As mentioned, these concepts are interconnected and build on each other's elements. For example, Winne (1992) asserts that self-regulation is a central feature of learning, that it can be taught, and that it is intrinsic to hierarchically organized systems. He draws some of his conclusions from Anderson's (1983) ACT* theories and other expertise findings, which suggest that the availability of cognition to conscious inspection generally correlates inversely with the learner's expertise (p. 358).

Similarly, the concept of situated cognition shares characteristics common to other concepts. Situated cognition appears in several models of instruction (Cognition and Technology Group at Vanderbilt, 1992; Vye and Cognition and Technology Group at Vanderbilt, 1998; Collins, Brown, and Newman, 1989; Palinscar and Brown, 1984; Reiber, 1992; Scardamalia and Bereiter, 1991; Schoenfeld, 1994). These models view instruction with a problem-solving orientation that could be considered either authentic or simulated, and which follows (or precedes) many of the critical aspects referred to in the expertise literature.

Due to the interconnectedness of different elements contained within these concepts, there are several underlying themes that provide a framework which can be used to promote better practices in teaching and learning. Shuell (1993, 1996) summarizes these themes when he considers current models of teaching:

> For the most part, these [teaching] models assume that (a) learning is a social process, (b) competence involves expertise rather than native ability, (c) learning, at least meaningful learning, is constructive and self-regulating rather than reproductive, and (d) classroom activities should reflect real-world learning rather than traditional academic tasks. (p. 751)

By incorporating these concepts into fields of overlapping inquiry, they can be understood as attempts at unifying mental psychological processes that have been the hallmark of the cognitive revolution. Each concept contributes towards our understanding of the holistic nature of human behavior and has powerful implications for both teaching and learning functions. As discussed in Chapter 3, each of these concepts is integrated into the design framework of Personal Finance on the Web.

Section II: Technology Integration Efforts in Instruction

Definitions of Technology

The Oxford English Dictionary defines technology as "the scientific study of the practical or industrial arts." The Association of Educational Communications and Technology (ACET, 1972) views instructional technology as "the facilitation of human learning through the systematic identification, development, organization, and utilization of a full range of learning resources, and through the management of these processes" (p. 36). Perolle (1988) goes further to situate technology in human social constructions: "Technology ... involves social processes that produce tools, the social behaviors involved in using the tools, and the socially defined meaning of tools." (p. 22).

In its wider sense, Shaw (1990) suggests that instructional technology draws from many disciplines and areas of study. These include organizational theory; administration; human resource planning; communication; educational psychology, including learning theory (drawing from behavioral, cognitive, information-processing oriented and development psychology) and educational measurement and evaluation; artificial intelligence or cognitive science studies; instructional theory and models of instructional design, the study of human factors and man-machine interaction; and educational cybernetics.

A Brief History of Instructional Technology

The educational meaning of technology is historically derived. Originating from the Greek form *techne* (art, craft, or skill), which was closely associated with *episteme* (systematic or scientific knowledge), all of these definitions emphasize technology not only as an artifact, but also as a process or means of accomplishing a goal. Furthermore, specific psychological theories and philosophical underpinnings with particular scientific orientations have directed inquiry in the area (Saettler, 1990).

Instructional technology has its roots prior to the twentieth century. John Comenius (1592-1670) was a teacher and theologian who created the first illustrated textbook for children and is considered the forerunner of modern programmed instruction. John Locke's (1632-1704) *tabula rasa* theory came to be the precursor of modern behavioral modification. Jean Jacques Rousseau (1712-1778) proposed an appropriate technology of instruction to follow different stages of human development. John Fredrick Herbart (1777-1841) developed the first four-step instructional systems approach. Maria Montessori (1870-1952) is credited with pioneering the development of graded materials, instructional sequencing and the adaptation of instruction to the child's individuality. Finally, James Sully (1842-1923) argued that teaching is a technological process and that instruction is both an art and a science.

According to Saettler (1990), the common thread running through all these contributions (and many others) is that "Instructional technology is essentially the product of a great historical stream consisting of trial and error, long practice and imitation, and sporadic manifestations of unusual individual creativity and persuasion" (p. 4). Technologies as conveyers of information have been used for centuries to "teach"; however, interactive technologies began to be introduced early in the 20th century to "engage" students in the learning process (Cuban, 1986).

Just as the printing press led humanity into the age of print (McLuhan, 1962), through marked changes in communication technologies successive introductions and innovations in instructional technology were heralded as revolutions that would displace existing systems. For example, in the first half of the century, film and radio were seen as replacements to existing forms of communications. Similarly in the 1950's, televison displaced film and radio. A decade later, computers were predicted to become the dominant technology of instruction. However, the new technologies did not completely displace the older ones. Instead, they redefined their roles and meanings in education (Fidler, 1996; Oblinger and Rush, 1997; O'Sullivan, 2000.)

Today, there is endless talk about the transformative nature of emerging technologies that have ushered in the "information age." Value is now created by the "digital economy" and fuelled by "knowledge workers." Indicators abound of such change resulting from the arrival of emerging technologies, and they continue to provide a context for new ways of educating learners "anytime, anywhere." Government reports call for retraining, as continually changing competencies are demanded in the business environment. The majority of workers require technological competence (Applebome, 1995), increasingly with collaborative skills (Hall, 1995). A significant proportion of the working population in North America works from the home. In terms of the proliferation of information on the WWW, Forman (1995) suggests that over ten thousand scientific articles are published each day and knowledge that used to double every seven years will henceforth double in just weeks.

Owston (1997), argues that the WWW is captivating the imagination and interest of educators around the world more than any other recent innovation. Web-based pedagogy is being touted as the most economical, egalitarian, and flexible means through which humans (will) learn.

The impact of web technology on e-business, e-training, e-entertainment, etc., is clearly visible, and the convergence of telecommunications and commercial activities has unmistakably become the economic engine of the "new" economy. The educational industry has taken note of the rapid and largely successful integration efforts of Internet-based technology in business and serious questions about web-based learning and multiple open-learning approaches are now being raised (Aggarwal, 2000; Daniel, 1998; Khan, 1997; Lajoie, 2000; Negroponte, 1995; Oblinger and Rush, 1997, Tapscott, 1999).

The evolution of the Internet and new WWW technologies can be traced in the research traditions of instructional computing systems. The following section focuses on these systems by reviewing the empirical and theoretical considerations underlying their designs. The significant contribution of John Anderson and his colleagues in this area is also recognized. This is followed by a discussion of design considerations that emphasize the importance of student learning. The implementation considerations of these systems are also discussed.

Computer Based Learning Environments

Computer-based instruction, intelligent tutoring systems, microworlds, databases, expert systems, simulations, tutorials and utilities are different types of computer based learning environments (CBLE's), each of which accomplishes different instructional objectives (Chen, 1995; Shuell, 1992). However, Shute and Psotka (1994) point out that one can conceive of computer assisted learning environments as lying on a continuum, from the linear computer assisted instruction to the autonomous intelligent tutoring system, with several hybrids in between. This section focuses on a computer-based *tutorial* system, which, according to McFarland and Parker (1990) in their excellent review, should locate tutoring and learning environments as part of Intelligent Computer Assisted Instruction (ICAI)[2]. Although ICAI has its roots in the early versions of auto-instruction and computer assisted instruction, (Atkinson, 1968; Crowder, 1959; Pask, 1960; Pressey, 1926, 1927, 1964; Skinner, 1954), it is clearly derived from research and development in artificial intelligence. The ability to adapt instruction to a large number of students through continuous reassessment is the main reason for believing that the computer medium provides pedagogical power over and above that provided by the paper-and-pencil medium (Ohlsson, 1993). Kearsley (1987) elaborates on this point:

> The dream of ICAI researchers is to provide each student with a computer-based tutor that has all of the qualities of a master teacher. This includes great scope and depth of subject matter expertise, excellent knowledge of teaching techniques, powerful communication skills, and the ability to inspire and motivate students to learn. (p. 158).

Koschmann (1996) categorizes the instructional use of technology based on the following paradigms: (a) computer assisted instruction, (b) intelligent tutoring systems, and (c) logo-as-latin paradigms. Each of these has distinct sets of assumptions and values, and raises implications for the "legitimate" research problems it poses, for the theoretical frameworks that accompany it (Kuhn, 1972), and for student learning.

Cooper (1993) has suggested that: "the progressive shift from a behavioral to a cognitive paradigm ... has been matched by a corresponding shift in the research and implementation of instructional technology supporting individualized instruction" (p. 169). This ideal of a personalized system of instruction has its roots in the Keller Plan (1963)[3], which allowed each student to proceed through an instructional

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[2] McFarland and Parker (1990) classify ICAI applications as: (a) mixed initiative dialogues, (b) diagnostic tutors, (c) articulate expert systems, (d) computer coaches, and (e) microworlds, which can be regrouped under intelligent tutoring systems and intelligent learning environments.

[3] Reiser (1987) documents a number of other forms of individualized instruction, including; Individually Prescribed Instruction (IPE), Program for Learning in Accordance with Needs (PLAN),

sequence at his or her own rate. This approach builds on Maria Montessori's (1870-1952) contributions in adapting instruction to the child's individuality at the turn of the century. The paradigm marked by the cognitive revolution is described in the next section.

Cognitive Considerations Underlying the Design of CBLE's

Instead of procedural decomposition, cognitive task analysis attempts to model the internal workings of the mind into functional components which handle information, filtering, storage in short-term memory, semantic encoding for storage in long-term memory, and retrieval when required (Steinberg and Gitomer, 1996). Tennyson and Park (1984) provide a model of the cognitive system, which suggests how basic cognitive functions, i.e., sensory receptors, executive control, working memory, and long-term memory are related to instructional needs. In reviewing empirically based models of computer-based adaptive instructional systems, he identifies six required characteristics that allow for moment-to-moment analysis and adjustment to learner responses: (a) initial diagnosis and prescription; (b) iterative updating; (c) criterion based learning; (d) response sensitive sequencing of instruction; (e) instructional time control; and (f) advisement strategies which promote learner control and improved performance (Tennyson and Park, 1984; Tennyson, 1992).

An adaptive CBLE incorporates at least four major components. These include the interface (the means for interaction), the student model (knowledge of the learner, error representation, etc), the expert model (database of correct knowledge states for a given domain) and the pedagogical model (knowledge of teaching strategies) (Orey and Nelson, 1991). This structure is significantly different from the earlier "knowledge-free" CAI routines (Shute, 1994).

Furthermore, adaptive CBLEs consistently apply cognitive theories that are relevant to learning and instruction. For example, in the area of problem solving and knowledge expertise, studies reveal that experts have a better ability than novices to detect the features of the problem and thus construct productive representations of the

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and Individually Guided Education (IGE). These innovations emphasized the role of the instructor from knowledge dispenser to planner, manager, tutor, and so on.

problem space (Anderson, 1983; Chi, Glaser and Farr, 1988; Lesgold, 1988; Lesgold and Lajoie, 1991; VanLehn, 1996). An essential difference in diagnosing the cognitive source of misconceptions and deep structure errors is what makes adaptive CBLEs radically different from CAI.

Anderson's Math Tutors

The technique for such diagnosis is exemplified in Anderson's model tracing approach Anderson (1983) and incorporated in several effective intelligent tutoring systems (ITS) (Anderson, 1990; Anderson, Boyle, and Reiser, 1985; Anderson, Boyle, and Yost, 1985; Anderson, Conrad, and Corbett, 1989; Anderson, Koedinger, and Mark, 1997). The hypothesis is that cognitive skills are encoded in the mind as a collection of rules that are arranged in an independent-modular fashion, such that the student only needs feedback that is relevant to each problem-solving step. Thus, each step of the student is matched against a rule library, or what Shute and Psotka (1994) call "a grand cognitive architecture dominated by production rules", where a remedial training message attached to the rule is invoked:

> The approach works by delineating many hundreds of production rules that model curricular "chunks" of cognitive skill. A learner's acquisition of these chunks is monitored (i.e., the student model is traced) and departure from the optimal route is immediately remediated. (p. 30)

The general strategy in model tracing presents the student with a problem, tracks the student's progress moment-by-moment, and intervenes with explanatory feedback in the case of an error or a request for help. If the student executes the rules that are considered correct by the system, the tutor remains silent; if, however, an illegal step is performed, the tutor intervenes with a suggestion to help the student diagnose the error and correct it, or by outlining an appropriate action to help bring the student back on track. The results reported by Anderson et al., (1995) indicate that these tutoring systems help students learn more quickly.

More recently, Anderson et al., (1997) report on the introduction and evaluation of a new algebra curriculum and a complementary intelligent tutoring system in an urban high school. The authors claim that students in the experimental classes outperformed students in the comparison classes by 15% on standardized tests and 100% on tests targeting curriculum objectives. The study addresses whether CBLEs can be used in practical ways. The authors use authentic problems and principles of anchored instruction. The underlying rationale for this project is based on bridging the gap between "school" mathematics and problems encountered in "everyday" life. The authors voice concerns that are shared by the vast majority of educators who are attempting to evaluate the role of the computer in the classroom. These concerns include design and curriculum issues, motivational issues, the use of appropriate representations and models for instructional purposes, and different methods of assessment.

To better understand these motivational aspects as well as other initially unintended affective and social dimensions in the classroom, Schofield, Eurich-Fulcer, and Britt (1994) provide additional insight gained from their intensive qualitative study of eight classrooms. The authors present the paradoxical finding that students who consistently rate teachers as being better in assisting their problem solving are nevertheless more motivated using computer tutors and prefer classes where the tutor is used. Possible explanations include the fact that the tutor functioned as an additional classroom resource (rather than as a replacement) and that the tutor positively changed the social dynamics of the classroom by fostering a level of friendly competition amongst students. Students were observed to start their work "more promptly and working through the last minutes of the period, ... appeared to be more engrossed in their work ....all indications were that their level of concentration rose." (p. 593).

While the tutor was a flexible net additional classroom resource, the teacher's help became more individualized, focused as it was on attending very specifically to a particular student's individual needs. Mistakes on the computer tutor tended to be more private, as was the teacher's help, thereby giving the students additional control in obtaining help and, perhaps more importantly, establishing a sense of independence and autonomy over their learning.

CBLEs and Student Learning

Similarly, research on the conditions that promote effective learning shows how explicit instruction on strategic knowledge can increase the learners's problem solving abilities in diverse domains including mathematics (Schoenfeld, 1994); reading comprehension (Palinscar and Brown, 1984); writing (Scardamalia and Bereiter, 1991, 1994), and the sciences (Gordin and Pea, 1995; Lajoie et al., 1995; Lajoie, Jacobs, and Lavigne, 1995). Furthermore, as documented by Wilson and Cole (1991) there is considerable variation between the different cognitive teaching models that have recently emerged (Anderson et al., 1997, and Clancey's, 1986, 1992 intelligent tutors; White and Frederikson's, 1986, qualitative mental models; Spiro et al., 1991 and Bransford and Vye's, 1989, anchored instruction).

Applying knowledge to authentic real-world problem solving scenarios suggests CBLE as an ideal environment to support experiential learning (The cognitive apprenticeship approach, Brown et al., 1989; Collins et al., 1989; Cognition and Technology Group at Vanderbilt, 1992). These models assume that students can acquire skills and knowledge by observing and increasing their active involvement with experts. In this learning process, where modelling, coaching, scaffolding, and fading techniques are employed, students learn facts, concepts, and procedures in the context of their use, thus helping them to develop flexible, adaptive, and transferable expertise (Cognition and Technology Group at Vanderbilt, 1992).

Development and Implementation Issues

There are several controversial issues relating to the development of CBLE's. Consider, for example, the matter of learner control. On one end of the continuum is a preference for discovery learning, and on the other end is structure and direction (Shute and Psotka, 1994). This issue was extensively reviewed by Merrill, Reiser, Ranney, and Trafton (1992) who found that human tutors leave as much of the error repair as possible to the students and that human tutors are more flexible and strategic. In addition, Hume, Michael, Rovick, and Evans (1996) describe different kinds of hints, distinguishing between "conveyed information" and "pointing to" hints. They discuss the format and structure of hints (such as explanations, summaries, questions, multiple intentions and negative acknowledgements), and outline the rules that determine when hints begin and end and how they are constructed.

Similarly, Derry and Lajoie (1993) and Derry and Lesgold (1996) articulated the philosophical differences between researchers on the role of adaptive CBLE's. One extreme believes that student thinking can be modelled, the other believes that it should not and cannot be. Derry and Lajoie (1993) take the "middle ground." Thus, whereas Anderson's previous tutors are clearly associated with the model builders, the more recent (Anderson et al., 1997) lean towards accommodating social constructivist views of education. Such views were originally articulated by von Glasersfeld (1988). They include what the "other camp" (non-modellers) have described as its hallmarks, namely, cognitive apprenticeship, situated learning and constructivist theory.

More recently, Lajoie (2000) clarifies that the essential question is not whether student thinking processes should or can be modelled, but who or what does the modelling: computers or human beings? Thus, given the changes and advances in which technologies are being used in education and training, the focus is on theory-based CBLEs that provide cognitive tools for learnes.

In addition, Anderson et al., (1997) individualizes instruction by discussing in detail the role of feedback and how help is provided on request. He points to the use of multiple representations of information (tables, graphs and symbols) as a major focus of the tutor. However, empirical findings in the literature demonstrating these aspects of CBLEs are not as clear-cut. Studies on feedback and motivational effects have reported mixed results (Azevedo and Bernard, 1995; Del Soldato and Du Boulay, 1995; Hativa and Lesgold, 1991; Issroff and Del Soldato, 1995; Lepper, Keavney, and Drake, 1996; Mory, 1992; Wager and Gagné, 1988).

Furthermore, what kinds of representations are more effective than other configurations, such as graphs, pictures, and video, and do these affect different types of learners? In this context Mayer (1997) reviews ten studies of effective multimedia instruction where he details the contiguity effect, and six studies of attribute-treatment interactions, which indicate that multimedia and contiguity effects are strongest for low prior knowledge and high spatial ability students.

Also, there are numerous issues about assessment. What portion of student work is based on group work? How are individual contributions measured? What are the relative weights assigned to the different tasks? Also, in the case of "self-pacing" scenarios in which students learn through lessons based on mastery of skill, what happens to those groups of students who did not meet the mastery criteria?

As discussed by Glaser, Lesgold, and Lajoie (1987), the usual forms of achievement tests cannot be considered effective diagnostic aids. Instead, qualitative indicators of performance need to be identified. The authors argue that intelligent tutors provide an ideal laboratory for investigating new assessment techniques because such tutors are *driven* by assessment of individual student knowledge. Someone who has learned to solve problems, make inferences, and be skilful in a subject matter domain has acquired knowledge structures that enable actions that influence learning, goal setting, and planning. While the authors admit that achievement measurement theory can distinguish between beginners and experts, there is still much to be done, not only in identifying the intermediate stages but also the transitions between levels. They outline a number of assessment dimensions that deal with knowledge and skill or that are determined according to various dimensions of performance, such as degree of structure, automaticity etc., and which indicate the development of competence. Assessment issues in the context of designing ICAI are also discussed extensively in the work of Cognition and Technology Group at Vanderbilt (1992); Shuell (1992), and Steinberg and Gitomer (1996).

Salomon, Perkins, and Globerson (1991) suggest that computer tools can function as intellectual partners that share the cognitive burden of carrying out tasks. Jonassen and Reeves (1996) argue that "the real power of computers to improve education will only be realized when students actively use them as cognitive tools rather than passively perceive them as tutors or repositories of information" (p. 696). In the broadest sense, cognitive tools refer to technologies, tangible or intangible, that enhance the cognitive powers of individuals during thinking, problem solving, and learning (Lajoie, 1993; Reeves, 1999). In their summary of cognitive tool research, Jonassen and Reeves (1996) recommend that cognitive tools have their greatest effectiveness when applied to constructivist learning environments, and when they are used to support reflective thinking that is necessary for meaningful learning.

In conclusion, one can argue that any learning system in its idealized theoretical form will present as many limitations as it will opportunities. This is acknowledged by Psotka, Massey, and Mutter (1988) who comment on such constraints:

> speed, power, resilience and portability of the computational environment; skill, patience, time pressures, and expertise of the learner; diversity of the user population; size of the knowledge domain and problem sets; need for updating and maintaining the ITS; skill levels to be trained; degree of over learning required; usefulness of adjunct media, video, sound or even physical mock-ups and simulators. The list can be easily extended and is extraordinarily long (p. 403).

Section III: Pedagogical Frameworks for On-line Learning Environments

Competition and Growth

As mentioned earlier under the section, "A Brief History…", the spectacular growth of the Internet and the World Wide Web has been a function primarily of economic interests. It also represents an escape from economic constraints of previous media. The premise of the so-called information age today is the delivery of information "anytime, anywhere" at minimal cost. This accelerates the demand for highly educated "knowledge workers." Private firms frustrated with higher education's inability to meet continuing educational needs of the "knowledge workforce" have appropriated sectors of the higher-education market and continue to design their own instructional versions of learning "products" that were once the exclusive domain of public institutions. (For example, Arthur D. Little School of Management, Dell University, Ericsson Wireless University, SunU, and Thomson University).

Recent articles in the *Chronicle for Higher Education*, *American Association of Higher Education Bulletin, Change Magazine, EDUCAUSE*, etc., have expressed serious concern with respect to the intense competition from new educational providers. These are, however, responding to market driven needs that focus on learner or customer satisfaction and student abilities to work with emerging technologies (Marchese, 1998; Roberts, 1998; Ruch, 1999).

Faced with these developments, as well as diminished resources from the public sector, distance education courses and virtual campuses are being seen by some as effective alternatives to traditional face-to-face instruction (Eklund, Garrett, Ryan, and Harvey, 1996; Katz and Associates, 1999; Laurillard, 1995; Oblinger and Rush, 1997). The Annenberg/CPB Project has compiled comprehensive information about the practice of distance education and lists a variety of sources (http://www.learner.org/edtech/distlearn/topten.html). Virtual institutions that offer a complete menu of degree programs are attracting substantial enrolments, and new players are establishing themselves in niche markets. In addition, laptop programs and alliances with commercial companies where technology integration is the stated mission of the institution continue to proliferate. (see Table 2.1 for examples and the largest commercial provider of online courses including ecollege company http://www.ecollege.com/company/). In the cover story of *Change*, Winston (1999) reports that accredited degree granting for-profit institutions like the University of Phoenix, DeVry, ITT, Education Management and many others are part of the Internet-based glamour stocks on the NASDAQ with price/earnings ratios of over 50.

Table 2.1

Sample of Virtual Universities and Canadian Laptop Programs

Virtual Universities	Address
Athabasca	http://www.athabascau.ca/
Athena University	http://www.athena.edu/
California Virtual University	http://www.california.edu/
Dutch Open University	http://www.ouh.nl/dhtml.htm/
Spectrum University	http://horizons.org/campus.html#top
Telecampus	http://telecampus.edu/
Tele Universite	http://www.teluq.uquebec.ca/webteluq/index.html
U. of Texas/World Lecture Hall	http://www.utexas.edu/world/lecture/
UK Open University	http://www.open.ac.uk/frames.html
Virtual University	http://www.vu.org/
Western Governors University	http://www.wgu.edu/wgu/index.html

Table 2.1 (continued)

Sample of Virtual Universities and Canadian Laptop Programs

Canadian Colleges with Laptop Programs:

Algonquin – http://www.algonquincollege.com/laptop/index.htm
Boreal – http://www.borealc.on.ca/innovations/
Connexion Dieppe – http://www.dieppe.ccnb.nb.ca/prog_connexion.cfm/
Durham – http://www.durhamc.on.ca/programs/business/accounting/laptopprogram/
La Cite Collegiale – http://www.lacitec.on.ca/pacte/
Sheridan College – http://www.sheridanc.on.ca/academic/mobile/
St. Claire – http://www.stclairc.on.ca/stserv/compfac/netcomm/

Canadian Universities with Laptop Programs:

Acadia – http://www.acadiau.ca/advantage/
Haute Etude Commerciale – http://www.hec.ca/virtuose/
Ryerson Polytechnic – http://www.ryerson.ca/link/
Alberta – http://www.law.ualberta.ca/students/technology/
Laval – http://www.fsa.ulaval.ca/ulysse/
Concordia – http://www-commerce.concordia.ca/programs/graduate/amba/index.html

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Properties of a New Instructional Medium – The WWW

As we have seen, the World Wide Web has become a ubiquitous electronic medium of communication where thoughts, ideas, and processes are shared, and where individuals learn and produce in bits, not in atoms (Negroponte, 1995). Setting the groundwork for principles commonly used in current Web-based instructional practices, Kozma and Johnston (1991) identify several ways through which information technology can be used in the transformation of teaching, learning and the curriculum. Owston (1997) argues that the Web can improve learning depending on how the medium is exploited. In his opinion, the Web offers three distinct advantages: (a) The web appeals to a majority of students who have grown up in a world rich in visual stimuli, (b) The web provides for flexible learning in terms of access and reflection opportunities, and (c) The web enables new kinds of learning that are skill-based, including critical thinking, problem-solving, written communication, and the ability to work collaboratively.

John Seely Brown has suggested that the WWW will be a transformative medium, as important as electricity was for social practices (Brown, 2000). He summarizes its fundamental properties: (i) It is a two-way "push and pull" broadcast medium where the user can at once be a receiver and sender, (ii) It honors multiple forms of intelligence including abstract, textual, visual, musical, social, and kinesthetic, and (iii) "...it leverages the small efforts of the many with the large efforts of the few" suggesting infinite combinations of interlacing resources that cut across geographical boundaries. Brown (2000) uses the concept of *bricolage* to describe how the web enables learners to construct knowledge that is deemed important:

> Learning becomes situated in action; it becomes as much social as cognitive, it is concrete rather than abstract, and it becomes intertwined with judgement and exploration. As such, the Web becomes not only an informational and social resource but a *learning medium* where understandings are socially constructed and shared. In that medium, learning becomes a part of action and knowledge creation. (p. 14)

This vision of Web technology that supports relationships between individuals and multiple views across communities of practice gives new meaning to the role of distributed learning. When used with other Internet tools, such as Usenet newsgroups, email, telnet, teleconferencing, videoconferencing, etc., as well as other distributed resources, opportunities for interaction abound (Pea and Gomez, 1992; Pea, 1993; Saloman, 1993; Saltzberg and Polyson, 1995). Wulff, Hanor, and Bulik (2000) highlight the hypermedia format of the Web and suggest its potential to encourage and sustain autonomous learning through critical actions, informed processes, and focussed procedures:

> Purposeful browsing, planned searching, and evaluative data retrieval, i.e., qualitative decisions about the value and relevance of data before mining it, can provide evidence of students' higher-order learning, particularly when coupled with self-motivated and self-controlled actions in a Web-based instructional context. Additionally, hypermedia formats have the potential to support non-linear, interactive, and individualized instruction (Becker and Dwyer, 1994), which may, in turn, increase the potential for constructing and maintaining self-directed, motivating, and learner-centered Web-based pedagogy. (p. 233)

On the other hand, in their meta review of hypermedia technology, Dillon and Gabbard (1998) report that: "Clearly, the benefits gained from the use of hypermedia technology in learning scenarios appear to be very limited and not in keeping with the generally euphoric reaction to this technology in the professional arena ... efforts could be focused on those components of learning that are amenable to technological support" (p. 346).

Another perspective on the dramatic potential of the Internet is offered by Ryder and Wilson (1996). Using Gibson's (1977) model of affordances, they conclude that the Internet overcomes many of the constraints imposed by traditional educational infrastructures, and the challenge for educators is to discover the capabilities associated with distributed pedagogy for scaffolding learners in the information age. On the other hand, Cole (2000) asserts that while it is clear that Web-based learning operates on a global platform that collapses time and space, web-based pedagogy privileges the written word. Cole (2000) argues that the learners' literary skills must be honed since current technology does not support moment-to-moment, real time discussion. Nor does it support think-aloud protocols, and the articulation and exchange of ideas that occur naturally in face-to-face interactions.

However, several authors have emphasized that traditional forms of instruction and research can be enhanced by simply altering and improving existing practices if they are synchronized with the capabilities of the Web (Bilotta, Fiorito, Iovane, and Pantano, 1995; Butler, Undated; Collis, Andernach, and Van Diepen, 1997; Margolis, 2000; Summary and Summary, 1998). Khan (1997) goes further by distinguishing between the key features inherent in integrated Web-based instructional designs and additional features that are dependent on the quality and sophistication of the design. The former includes interactivity, multi-medial, open, searchable, device-distance-time independent, globally accessible, electronic publishing, resource-based, distributed, cross-cultural, learner-controlled, etc., while the latter includes convenience, user-friendly, supportive, authentic, non-discriminatory, cost-effective, collaborative, etc. Advances in technology provide new opportunities for the production and consumption of knowledge and new opportunities for the continuous improvement of rich learning environments.

The next section examines several models of Web-based instruction and highlights the underlying principles associated with best practices.

Web-based Instructional Models and Best Practices

Dolence and Norris (1996) argue that new student-centered design models are essential in meeting the needs of the information age. They emphasize the following processes and mechanisms that need to be addressed in technology-based designs: (a) open access, to (b) a network of experts, in (c) both traditional and hybridized disciplines using (d) just-in-time learning, providing (e) perpetual learning, facilitated by (f) automated, "fused" learning systems, and (g) unbundled learning experiences based on learner needs.

Dolence and Norris (1996) emphasize that networked resources allow the student almost infinite flexibility in time, place and pace. This flexibility is represented in Bourne, Brodersen, Campbell, and Dawant's (1995) alternative educational model which contrasts pedagogical activities with the dominant lecture model. In this model, the student is at the center, with flexible access to peers, experts, other schools, and learning resources. The technology implications of moving in this direction are highlighted in Table 2.2.

Table 2.2

An Alternative Educational Model

Lecture Model	Alternative Model	Technology Implications
Classroom lectures	Individual exploration	Networked Computers with access to information databases
Passive absorption	Apprenticeship	Simulations
Individual work	Team learning	Email and Collaborative tools
Omniscient teacher	Teacher as guide	Network access to experts
Stable content	Dynamic content	Publishing tools, multimedia, etc.
Homogeneity	Diversity	Multiple tools and methods

Source: Oblinger and Rush, 1997, p. 15.

Recent developments in the WWW enable the vision suggested by the alternate model described above. An obvious advantage of the WWW is that it "publishes" a rich array of learning resources. According to Reeves and Reeves (1997) the web is a resource to support effective instructional dimensions and should only be used for a learning environment when its unique affordances are appropriate to the needs that have been identified for faculty and students.

Today, sophisticated software allows the designer and learner to manipulate databases, spreadsheets, and multimedia. It also facilitates networking between peers and experts. The WWW is the medium where these tools and activities converge. Information on the WWW is searchable, updateable, replicable, linkable, and distributable. The challenge for the designer is to identify the appropriate configuration of learning resources and partners, so that they serve as pedagogical devices. For example, Greer et al., (2000) have created tools for peer help. Using artificial intelligence techniques, their "Help-Desk" project employs computer-supported collaborative work tools characterized by their ability to react to individual differences among learners.

Mason (1998) outlines a simple framework for considering the wide range of online courses offered at the Open University in the UK. Most of these courses are classified according to three on-line models. The first, "Content + Support Model" lies at one extreme where the course content and tutor support are separated. In the case of the second "Wrap Around Model", learning activities revolve around existing course materials. The third "Integrated Model", is dependent on creating a collaborative learning community that is responsible for co-constructing learning goals with the instructor. This model is consistent with the cognitive tools approach advocated by Jonassen (1999), Lajoie (1993), and Reeves (1999).

Integrating pedagogical devices is detailed by Bonk, Cummings, Hara, Fischler, and Lee (2000) in a ten-level Web integration continuum. This continuum depicts pedagogical and technological choices that faculty should consider when developing Web-based course components. At the first level, the Web serves as a repository for syllabi and announcements, or as a marketing tool that promotes the course. At the second level, the Web can provide resources for students to explore related links to other websites. At the third level, the Web can be used to generate and showcase student work and publish exemplary outcomes that can be recycled and refined for the next group of students. At the fourth level, courseware such as lecture notes and power-point presentations are included to expand the resources identified in level two. At the fifth level, Web resources can be repurposed for other instructors and students. This may include a case study that can be used anywhere in the world. In summary, whenever the Web is used at the first five levels, it is effectively an information source and a place to share resources and completed work.

At the sixth level, the Web becomes an essential component of the course experience. Online discussion, peer critiquing, processing and constructing knowledge products, etc., are examples of level-six activity, and are most often assessed for grades. In a recent study by Beaudin (1999) online instructors rated the following top four techniques for keeping asynchronous online discussion on topic: (a) careful design of questions, (b) guidelines to help learners prepare on-topic responses, (c) reword the original question when responses are going in the wrong direction, and (d) provide discussion summary on a regular basis. Berge and Collins (1995), Brown and Thompson (1997) and Harasim (1990) argue that online educational interaction can be the hallmark of learner centeredness since it can be revised, archived, and retrieved. They also suggest that when such interactions are combined with collaboration, it can result in deep learning through the construction, revision, and sharing of knowledge.

At level seven, students communicate with others outside the class, including practitioners, experts, or instructors from other regions. This area of telecommunication projects has seen tremendous growth ever since educators developed successful learning projects around email (Berenfeld, 1996). However, in a meta analysis, Faboos and Young (1999) critiqued the research on telecommunications in the classroom and concluded: "Telecommunications exchanges are lauded by educational researchers and industry experts for enhancing writing and collaboration skills, increasing multicultural awareness, and expanding future economic possibilities, As we have seen, however, many of these benefits are inconclusive, overly optimistic, and even contradictory." While this critique is directed more towards the research community, practitioners remain enthusiastic.

Level eight turns the Web-course into a stand-alone operation that can be taken by resident students "anyplace, anytime." Level-eight features are apparent in *SMART* environments (Scientific and Mathematical Arenas for Refining Thinking) developed by Vye and Cognition and Technology Group at Vanderbilt (1998) as well as in the *Smartweb* (http://www.indiana.edu/~smartweb), an undergraduate psychology course. Level eight is of particular significance to this study since the intended design of the Personal Finance course has been targeted to reach this level. Although level-eight courses are likely to proliferate in the near future, presently they appear to be the exception rather than the rule.

Levels nine and ten are intended for students located anywhere in the world and fit within larger programmatic initiatives of a department, university, or Internet service company.

Two other models of Web-based instruction are worth noting. One is by Reeves (1997); Reeves and Reeves (1997) who base their work on Caroll's (1963) model of school learning. Reeves (1997) identifies three goals underlying his design, including knowledge and skills, robust mental models, and higher-order outcomes. Learners are characterized by their aptitude and individual differences, their cultural habits of mind, and the origin of underlying motivations. The WWW offers learners opportunities to (a) construct learning, (b) to take ownership, (c) a sense of audience, (d) collaborative support, (e) teacher support, and (d) metacognitive support. The inputs of this model (learner characteristics), the process which enables learning, and the outcomes (goals) provide a framework to encourage other developers to consider the WWW both for teaching and research.

The second model is based on the work of Hannafin and Land (1997) and Hannafin, Land, and Oliver (1999) who integrate the practices of learning systems design with related theory as these apply to constructivist, open-learning models. Guiding principles that influence open-learning models are organized under the following categories (a) Pedagogical, (b) Psychological, (c) Technological, (d) Cultural, and (e) Pragmatic. This model is discussed in detail in Chapter 3.

Robust models of Web-based instruction are grounded in theoretical frameworks that guide the designer to enhance student social interaction, knowledge building, higher-order thinking, and reflection. For example, Bonk and Cummings (1998) link a dozen guidelines for using the Web in instruction to the fourteen learner-centered psychological principles from the American Psychological Association. Hannafin and Land (1997) provide numerous examples, functions and supporting research for the assumptions of student-centered learning environments (see table 1 on pages 182-186). Similarly for Gillani, (2000), the Web is an ideal tool for applying Vygotsky's theory of scaffolding students through the phases of the zone of proximal development. The architecture of a web site can be designed to serve a socially situated educational setting that is responsive to the personalized needs of students.

Others have provided different theoretical perspectives but have emphasized the importance of theory in guiding the design and development of Web-based instruction. For an extensive discussion of these perspectives, related design experiments, and Web-based instructional models (see Abbey, 2000; Aggarwal, 2000; Bonk and Cummings, 1998; Butler, 1996; Cole, 2000; Cognition and Technology Group at Vanderbilt, 1996; Duchastel, 1997; Jonassen and Reeves, 1996; Khan, 1997; Lajoie, 2000; Reigeluth, 1999; Sugrue, 2000; Yankelovich, Meyrowitz and Drucker, 1998).

Many of the elements identified in the models reviewed above reflect what experts consider to be "best practice." There are many dimensions to the design of technology intensive environments on the WWW. Some of the common factors include: (a) models are driven by theoretical, empirical and other developmental goals, (b) models are inclusive in accommodating diversity, learning styles, affect, etc., (c) models view technological tools as servants for the achievement of specific cognitive and social objectives, and (d) models radically redefine the traditional role of both the teacher and learner. Finally, many of the models reviewed are driven by a pragmatic epistemology that regards learning theory as being collaboratively shaped by researchers and practitioners. This epistemology is discussed in the following section of design experiments.

Design Experiments

This study pertains to a methodology that is rooted in developmental or action research that is intended to improve design theory related to instructional practices and processes. It reflects what Brown (1992) originally referred to as *design experiments* and what Greeno, Collins, and Resnick (1996) and others label as *formative research*, in which "researchers and practitioners, particularly teachers, collaborate in the design, implementation, and analysis of changes in practice." (p. 15).

In contrast to descriptive theories of learning, design theories in an applied field like education, (a) focus on the means to attain given goals for learning, (b) identify instructional methods and situations where these may be applied, (c) offer guidance to educators, and (d) are probabilistic rather than deterministic (Perkins, 1992; Reigeluth, 1999; Wilson, 1995; Winn, 1997).

The research strategy is based on the following three critical characteristics of design experiments: (a) addressing complex problems in real contexts in collaboration with practitioners, (b) integrating known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems, and (c) conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to design new principles (Brown, 1992). This approach is what educational experts have labeled as "formative research" (Neuman, 1990); "development research" (Akker, 1999); and "use-inspired research" (Reeves, 2000); Stokes, 1997).

Design theories have been viewed as prescriptive ever since Dewey (1904/1965) suggested that a theory could help the practitioner think about practical problems in different ways. Design theories have traditionally dealt with applied questions relating to *what* (methods) and *how* (to teach), which have resulted in decision-oriented inquiry (Cronbach and Suppes, 1969; Simon, 1969; Snelbecker, 1974). More recently, Jonassen (1999) offers a broader view of design theories:

> Like the spine that is realigned by the chiropractor, we might become healthier from a realignment of our theories. The theoretical adjustment would neither constitute nor command a new theory of instructional design – only broaden our conceptions by

> accommodating multiple perspectives... that will have more powerful (if not predictable) effects on human learning. (p. 1)

Jonassen's (1999) comments are especially applicable in technology enriched constructivistic environments that are learner-centered. In order to create opportunities for the learner to achieve the desired instructional objectives, emerging web-based designs that are grounded in a theoretical framework require a shift from decontextualized learning to authentic, meaningful tasks (Bonk and Cummings, 1998, Bonk et al., 2000; Hannafin, Land, and Oliver, 1999; Jonassen, 1999; Schwartz et al., 1999; Vye and Cognition and Technology Group at Vanderbilt, 1998). While numerous empirical studies have attempted to test and build on design theories in traditional teaching environments, theories are needed to clearly conceptualize the dimensions of learning that support technology-rich learning environments.

Research Objectives and Questions

There are very few design theories and a pronounced lack of empirical results in technology-rich web based learning environments. This study proposes a general integrated model of learning for a web-based course. The primary objective of the study stated in two parts is outlined below. Secondary objectives seek to identify other findings from data collected.

1. Identify the existence of a theory-based model of learning for a web-based course:
    a) Develop and validate a measurement instrument of learning that would clarify the conceptualization behind this instrument. This instrument represents the methodological objective that will use state-of-the-art structural equation modeling to identify the dimensionality and psychometric properties of the scale.
2. Test for the influence of variables identified in the literature that may have a potentially significant impact on learning.
3. Identify other findings that profile participant characteristics including:
    a) background information
    b) motivational aspects
    c) prior knowledge
    d) proficiency with online tool use

4. Provide results from various surveys and evaluations conducted for the course.
5. Discuss the implications of results that offer guidelines for the development of Web-based instructional models and to promote further inquiry in this area.

The primary objective of identifying and testing a theory-based, integrated model of learning can be characterized by a five-stage approach as suggested by Bollen and Long (1993). This involves (a) model specification, (b) identification of items, (c) estimation procedures, (d) testing the fit between the model and the data, and (e) re-specification or fine tuning to improve the model. Structural equation modeling is inherently a confirmatory technique and its main purpose is to explain why variables are correlated in a particular fashion. It was selected as the appropriate statistical tool, since it is based on the premise that (a) every theory implies a set of correlations, and (b) if the theory is valid, then it should be able to explain or reproduce the patterns of correlations found in the empirical data.

Sub-objective 1a) will follow Churchill's (1979) procedure to develop better measures of identifying variables used in model specification. This procedure is detailed in the analysis and results section in Chapter 4. The ultimate goal of using this procedure is to propose a valid and reliable measure of learning that could be used and tested in different contexts. Objective 2 represents the structural parts of the hypothesized model. The combination of these two components constitutes the integrated model of learning that is the cornerstone of this research.

CHAPTER 3
A WEB-BASED DESIGN FRAMEWORK FOR PERSONAL FINANCE

An Open-Ended Learning Environment

In the literature review, four key concepts were integrated in a conceptual framework for meaningful learning: (a) Situated Cognition, (b) Expertise, (c) Pedagogical Content Knowledge, and (d) Self-Regulation. Open learning environments (OLE's) are based on constructivist principles that attempt to accommodate multiple theories and conceptual models for designing student-centered instruction. OLE's are distinct from traditional designs, philosophically as well as in the applied sense (see Table 3.1).

OLE's emphasize situated cognition by focusing on meaningful problems in context and on authentic experiences. An expertise framework is also evident as individual efforts to understand are supported via metacognitive scaffolding, and tools through which resources can be deployed for deliberate practice and chunking of information. OLE's provide instructors with the opportunity to demonstrate pedagogical content knowledge by embedding learning activities that foster thinking based on practical experiences rather than on description of abstract phenomena. They also promote self-regulation by providing opportunities to develop individual understanding through decision-making that can be modified, tested and revised.

In *Personal Finance*, the expert model is evident in several ways. First, the video series produced for this course profiles 16 experts who introduce various related topics. Second, 5 experts specializing in specific topics (for example, taxes, securities, etc.) coach students by responding to their questions and by providing selective feedback on tasks assigned for assessment. These scaffolding activities are facilitated by FirstClass™, a communication software that allows messages to be posted and exchanged in designated folders (see Figure 3.12). Third, peer expertise is evident through exemplary discussions, critiques and assignments which are posted in FirstClass™ folders. Finally, instructor expertise is apparent in selective interventions where participants present their work in progress and where feedback is given on completed work.

In addition, the review of Web-based models and instructional practices in chapter 2 highlights several features common to OLE's. For example, these Web-based models are inclusive in that they accommodate learner diversity; they make use of cognitive tools for meaningful activities and radically redefine the traditional role of both the teacher and the learner. OLE's share the same characteristics. According to Hannafin, Land, and Oliver (1999) open-endedness refers to "either the learning goal(s), the means through which learning goals are pursued, or both learning goals and means" (p. 119). In *Personal Finance* four categories of tools were selected: (a) print-based, (b) video-based, (c) web-based, and (d) computer-mediated communication (see Table 3.4). Each served to mediate between the learning objectives, the teaching/learning tasks and the assessment methods that had been devised.

Following the theoretical framework of OLE's, this chapter outlines the design elements of *Personal Finance*. It also provides important links between learning goals, learning activities, and assessment practices. It presents several screen captures to give the reader a better sense of the learning environment. It also provides highlights on the pragmatic decisions that had to be made given various time and resource constraints.

Table 3.1

Distinctions Between Directed Learning and Open-Learning Environments

Directed Learning Environments	Open-Ended Learning Environments
Break down content hierarchically and teach incrementally toward externally generated objectives	Situate processes associated with problems, contexts, and content with opportunities to manipulate, interpret, and experiment
Simplify detection and mastery of key concepts by isolation and instructing to-be-learned knowledge and skill; "bottom up," basics first	Employ complex, meaningful problems that link content and concepts to everyday experience where "need to know" is naturally generated
Convey knowledge and skill through structured, engineered teaching-learning approaches	Center heuristic approaches around "wholes" exploring higher order concepts, flexible understanding, and multiple perspectives
Mediate learning externally via explicit activities and practice; promote canonical understanding as a goal	Develop understanding individually as learners evaluate their own needs, make decisions, and modify, test, and revise their knowledge
Activate internal conditions of learning by carefully engineering external conditions	Link cognition and context inextricably
Achieve mastery by focusing on production of "correct" responses, thereby reducing or eliminating errors	Stress the importance of errors in establishing models of understanding; deep understanding evolves from initial, often flawed, beliefs

Source: M.J. Hannafin, J. Hill, and S. Land (1997). Student-centered learning and interactive multimedia: Status, issues, and implications, Contemporary Education, 68, p. 94-99. Reprinted with permission from the publisher.

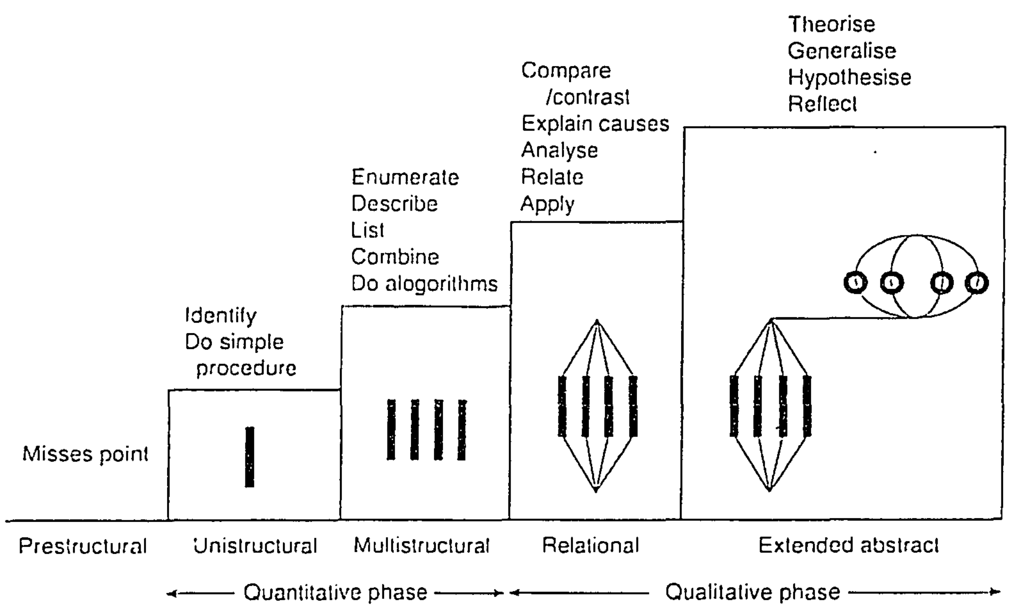
Teaching Objectives and Learning Outcomes

For Ramsden (1992), any model of teaching that depicts "teaching in action" (observable activities related to specific aspects of teaching) must be preceded by the instructors' general theories of teaching, both of which are affected by the quality of reflective thought (p. 119). I begin by defining my theory of instruction as Ramsden's (1992) Theory 3: "Teaching as making learning possible." This statement is consistent with other tenets of what is generally considered to be good educational practice[1]. Very few instructors will disagree with Theory 3.

But as Biggs (1996; 1999) clarifies, while all teachers say they "teach for understanding", few do so in any sustainable way. His personal deviation from the rhetoric is illustrated by the SOLO (Structure of the Observed Learning Outcome) framework which includes a hierarchical list of "performances of understanding" ranging from the barely satisfactory "prestructural level of activity", to the most desirable "extended abstract level" (p. 354). See Figure 3.1.

Figure 3.1

A Hierarchical Model of Learning for Forming Curriculum Objectives



Source: Biggs, J. (1999). Assessment: An integral part of the teaching system. AAHE Bulletin. 51(9), 12. Reprinted with permission.

[1] See Chickering and Gamson (1987) for their widely circulated "Seven principles for good practice in undergraduate education."

Using the SOLO taxonomy a range of objectives for Personal Finance was developed with the intention of defining the quality of learning associated with each level (see Table 3.2). In formulating individual and collaborative objectives, verbs such as understanding, speaking, researching, evaluating, articulating, and analyzing were used because they capture various perspectives from constructivist, cognitive, and situated approaches and because they are consistent with my pedagogical beliefs. While each objective has different implications for personal development, all are congruent in that they expose students to all aspects of personal finance, including the basic financial planning strategies of managing one's money and investments.

Table 3.2

Course Objectives

Unistructural

- Understand the terminology and basic concepts underlying personal financial management.

Multistructural

- Speak the language used in making personal financial decisions.
- Research valid sources of information that enable individuals to make sound personal financial decisions.

Relational

- Evaluate media reports and popular publications on personal financial management.
- Analyze and problem-solve basic questions as well as simple cases that involve multiple concepts in personal finance.
- Work collaboratively with peers, practitioners and the instructor in developing expertise in at least one area of personal finance.

Extended Abstract

- Articulate how views relate to some fundamental issues in personal finance and develop these into action plans where applicable.
- Plan, organize, and apply some personal financial decisions to your own situation or seek advice from professionals where appropriate.

Teaching / Learning Activities

Using Shulman's (1987) model of pedagogical reasoning and action, instructors who had previously taught the classroom-based course met with invited expert practitioners from the field. Sixteen practitioners were videotaped in order to produce short vignettes for the web. These practitioners included seasoned professionals (for example, presidents of personal financial consulting firms) as well as recent graduates who were working in the field. Each introduced a particular topic in personal finance. The instructor and the practitioners reflected on personal experiences with making financial decisions and identified learning needs of individual students. These needs were based on a survey conducted the previous summer (see Appendix A) where fifty undergraduate students from different faculties responded to a battery of questions exploring their knowledge about the subject matter, their attitudes towards distance learning, and their preferences for online tool use. They also answered open-ended questions relating to their knowledge of and experience with personal financial issues.

The input obtained from these meetings, the results gleaned from the survey and the previously discussed list of learning objectives, as well as the feedback from a brainstorming session contributed to the identification of possible learning activities that would be characterised by an open-learning environment. The preliminary list of learning activities was refined and closely aligned with the objectives of the course, as well as with how those objectives would be assessed.

Since students taking a finance course for the first time have minimal pre-requisite knowledge, the instructional principles aimed at developing their knowledge base would rely on what Tennyson (1996) refers to as expository, practice, and problem oriented strategies. These include a contextual introduction of concepts, worked examples, and problems that have not previously been encountered. They also include simulations that require the student to (a) analyze the problem, (b) work out a conceptualization of the problem, (c) define specific goals for coping with the problem, and (d) propose a solution or decision.

Again, it is instructive to recall Biggs (1996, 1999) use of the "constructive alignment" of teaching learning activities:

> "It must be emphasized that, though, this [selection of teaching learning activities] should not involve the simple addition of a "good" technique; it is chosen because its function and purpose cohere with one's total teaching system" (p. 354).

This system recognizes that the teacher is not the only agent responsible for teaching/learning activities, since peer-controlled activities and self-controlled activities exert powerful influences in the learning process, a point emphasized in Moore's (1994) discussion of the Perry Schema as a framework for intellectual and ethical development. For students to really become immersed in the language of personal finance, to understand financial axioms, principles and concepts, to demonstrate their understanding in applications of simulated, authentic problems, and to reflect on their own work, the learning activities listed in Table 3.3 were defined.

Table 3.3

Assessment Activities

(1) *Finding an article* or website enables the learner to research valid sources of information, evaluate its authenticity, establish its merit and find connections that are personally meaningful.

(2) The *article critique* elicits reactions on popular publications as students work collaboratively to produce a draft of their work. Peer feedback is used in a cycle of progressive refinement as students reflect, scaffold and enrich each others' work which is showcased publicly. This activity enables students to articulate their views on issues they have defined as meaningful, and offers opportunity for reflection as they participate in a community of learners that displays their work(s) in progress.

(3) The *assignment* provides another vehicle for students with different learning styles to select activities that are most meaningful to them. Several choices are provided; these range from creating worksheets (to produce a personal financial plan, a tax return, a retirement package, or an investment portfolio) to analyzing cases where multiple skills are required in identifying and analyzing relevant issues, as well as generating appropriate solutions.

(4) *Discussion activities* mark the cornerstone of constructivist design. Discussion threads, story writing and feedback activities have been designed to elicit authentic, purposeful, and meaningful articulation of experience as it relates to concepts in the course. In order to monitor, coach and scaffold a large number of students, several practitioners were asked to volunteer by intervening and providing feedback to the discussion forums.

(5) Tests are also geared to prepare students to master a "formative" test (attempted on-line) and a "summative" off-line test at the end of the semester. The purpose of these assessments is to signal to students that they must obtain at least a minimum level of competence in certain quantitative and qualitative aspects of the course (for example, value calculations, familiarity with basic concepts, applications, etc).

Learning activities are purposely aligned with learning outcomes and deliberately follow the tenets of the knowledge construction paradigm discussed in Chapter 2. Authentic cognitive tasks like those mentioned for individuals and groups reflect ordinary corporate practices and are introduced in order for students to develop the same skills that are used by experts, as well as to socialize them into a community of practice. For example, a folder on the course web-site is entitled “Experts.” Students are encouraged to post questions to experts who specialize in topics such as financial planning, retirement, wills and estates, taxes, and mutual funds. Instructors and practitioners hired to monitor this folder also participate in general discussion threads through selective intervention and by providing feedback.

Using this approach, learning occurs through a mixture of novice communities absorbing expert knowledge and expert communities of practice helping the novices to become intellectual members of these communities (Derry and Lesgold, 1996). Procedural knowledge for problem finding, problem solving activities and general strategies, or what Perkins and Salomon (1989) refer to as “the intimate intermingling of generality and context specificity in instruction” (p. 24), has also been included.

<u>Assessment</u>

The quality of performance in the course is based on a portfolio approach, where critical and reflective assessments demonstrate conceptual change. This SOLO approach includes the following assessment benchmarks:

“A” Formulating a personal financial plan based on fundamental principles, axioms and representations of concepts. Artifacts: A worksheet detailing a personal financial plan; a position paper or critique; an extensive case study; mastery in declarative and other higher-order classifications of learning as reflected in Tests I and II.

“B” Ability to perform meaningful analysis and apply concepts in problem-based scenarios. Artifacts: Analysis of personal financial statements; mastery of mini-cases; ability to problem-solve quantitative questions and articulate opinions.

“C” Knowledge about a reasonable amount of content, meaningful discussion and presentation using appropriate terminology and techniques. Artifacts:

Problem-solving of concept tests; development of threads in discussion groups; presentation of results from assignments.

"D" Ability to identify relevant information, perform simple procedures, and ask questions. Artifacts: Perform searches, post questions, attempt end-of-chapter review questions.

From an instructional (expertise) perspective, for these outcomes to be valid would require a high degree of correspondence with similar goals shared by peers and practitioners in the field. The most desirable learning outcome, "A", recognizes the critical importance of self-regulation, since the demonstration of understanding requires metacognitive aspects as well as other self-regulation elements discussed earlier in Chapter 2. For example, the purposeful use of a case study presents opportunities to simulate authentic decision scenarios that the learner is likely to encounter in everyday practice. Also, the benchmarks illustrate the hierarchical nature of the tasks. In order to achieve performance outlined in "A", level "B", "C", and "D" activities must have been mastered.

The framework for assessment represents expected outcomes (Table 3.3) exemplified by artifacts. These expectations are spelled out early in the course outline including detailed assessment procedures and instructional practices (Appendix I). Students must produce evidence showing conceptual change (Biggs, 1996), where it is the instructor's responsibility to provide ample opportunities for them to identify and demonstrate the desired changes. Accordingly, a portfolio approach is advocated which gives reasonable choices for students on assessment tasks that are elicited (or required) by the very nature of the course design. Items to be included in a student's portfolio include the personal discussion folder, reports, critiques, position papers, case analyses, concept tests, etc. These provide concrete referents with which the instructor can guide and support the learner to attain his or her own goals. It also allows students to become better informed, thoughtful, and reflective assessors of their own efforts.

The website also emphasizes the performative aspects of assessment so that student artifacts of learning evolve in a public forum where they function in situations similar to those expected in real-world settings. Again, methods of instruction, learning, and assessment activities are not only instruments for the acquisition of knowledge and skills per se. They are also practices whereby students learn to participate, contribute to their identities as learners, take initiative and responsibility for their learning, and function actively in the formulation of goals and criteria for their success (Greeno, 1997).

Other Considerations

In terms of the finance curriculum, personal finance was considered by both departmental and faculty curriculum committees as having unique attributes. First of all and most importantly, it could benefit any student in any program including independent students, as well as faculty and staff members. Indeed, it would be of interest to anyone in the community! As a result, accessibility and accommodation of diverse learners were important considerations. In this regard, the course fits nicely with the Business Faculty motto of "real education for the real world." It is also consistent with departmental objectives, which include the provision of a diverse curriculum to complement a breadth of course offerings as well as a complement to other advanced courses to allow for specialization within the finance field.

In terms of instructional practice, the role of the instructor is dramatically altered. The teacher is no longer omniscient and must fade back from the traditional center stage role as the primary source of information and expertise. Instead, in an open-learning approach, the instructor serves as a guide and coach by strategically intervening in assigned tasks and work-in-progress by providing selective feedback and by providing access to a network of experts and learning resources. Thus, the locus of control for information and assessment get distributed to other experts, teaching assistants and support staff. Six experts, two teaching assistants and two dedicated technical support staff members performed a variety of course management activities for this course. As well, the students played a key role in assisting and learning from each other.

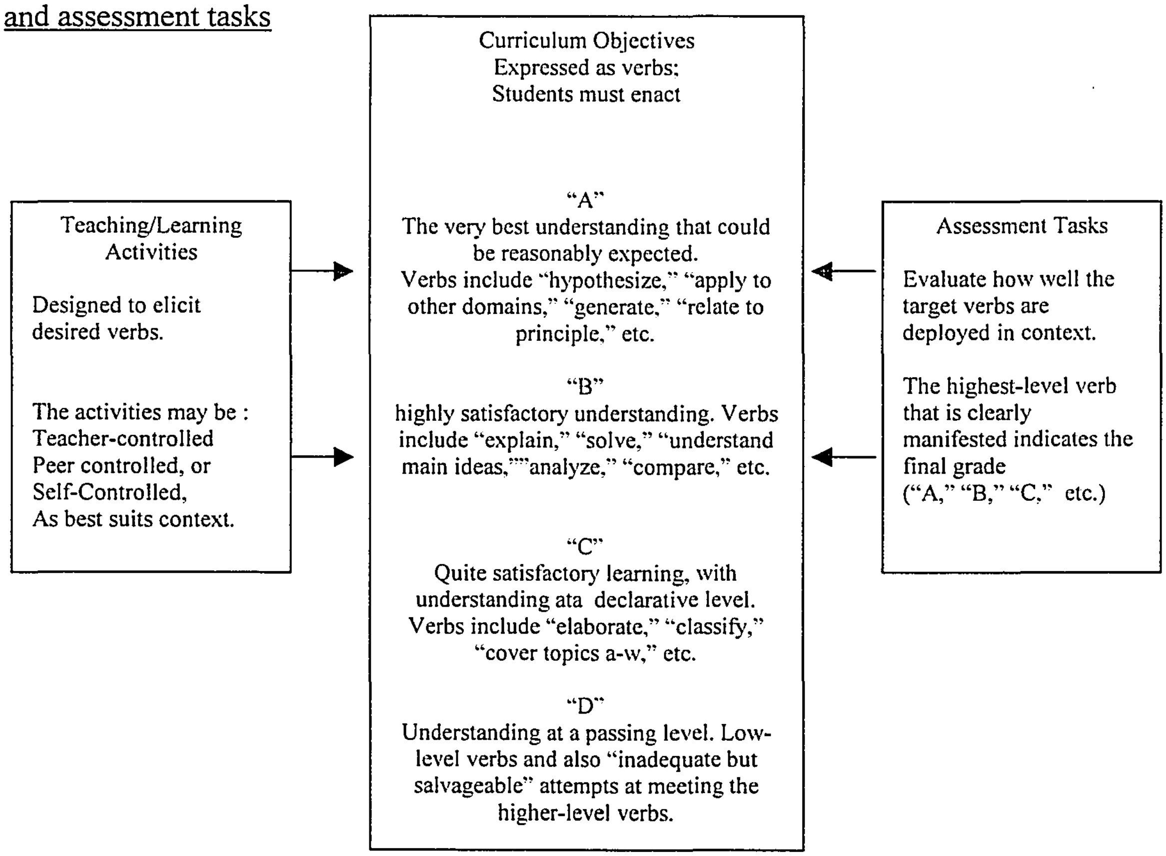
Alignment

Biggs (1996, 1999) refers to "constructive alignment" between objectives, activities, and assessment tasks (see Figure 3.2). In *Personal Finance*, alignment of these design components had to be consistent with the choice of cognitive tools that mediated between the learning objectives, activities, and assessment tasks. Mediating tools were also considered critical in terms of their representational and symbolic attributes. For most participants, the learning objectives are not easily understood since they represent the conceptualization of outcomes by experts. However, mediating tools directly interface as tangible or visible objects that participants interact with.

The next section explores the choice of mediating tools as they fit within the entire design. This is followed by Figure 3.6 which integrates all of the design elements used in *Personal Finance*. Figure 3.6 highlights the importance of alignment between all the components. This alignment represents components of design that mutually define each other and are inseparable in the sense that the removal of one part would require realignment of all the other parts.

Figure 3.2

Constructive Alignment: Aligning curriculum objectives, teaching/learning activities, and assessment tasks



Source: Biggs, J. (1999). AAHE Bulletin, 51(9), 12. Reprinted with permission

Mediating Tools

Building a technological foundation for a web based medium poses additional challenges in devising, processing, manipulating and communicating tools that optimize learning resources made available for the course. Bourdeau and Bates (1996) discuss the importance of access, training, and costs as important variables in the selection of appropriate tools in distance education applications. In addition, several examples of tool configurations that actively engage the learner, promote collaborative learning and highlight constructivist and situated learning approaches can be found in Abbey (2000), Aggarwal (2000), Bonk (1998), Cole (2000), CTGV (1996), Jonassen and Reeves (1996), Khan (1997), Lajoie (2000), Reigeluth (1999), Vye and CTGV (1998) and Yankelovich, Haan, Meyrowitz, and Drucker, S. (1998).

The selection of mediating tools is also a function of the instructor's expertise, as well as his/her relationship with the team responsible for technical aspects. These are bounded by time and the resource constraints imposed at the department, faculty and university level. Those experienced in the design and implementation aspects of a technology intensive course are quick to point out the high risks associated with server downtime, lack of maintenance and support, and high attrition rates amongst students. These are especially acute in a distance educational setting. Also, there are high opportunity costs for instructors in terms of traditional research activities and steep learning curves with respect to familiarity with new technology based systems, even if the course designer is identified as an innovator.

The range and sophistication of content presentation on the web ranges from posting lecture notes and tutorial packages to using communication tools (for example, Bulletin boards, chat, e-mail) to incorporating advanced interactive learning environments. In addition, interface design principles (for example, usability, visibility, simplicity, etc.), navigational issues (for example, information space, degree of learner control, inquiry versus discovery, etc.), and learner centered design issues (for example, motivating, accommodating diversity, adapting to learner growth, etc.), afford additional opportunities and constraints (Pantel, 1998). However, the basic question remains: Which tools should be selected and how does one select them?

In *Personal Finance*, just as the learning objectives were derived from a wish list of instructors, professionals, and survey input from potential students under the guiding framework of an open-learning environment, mediating tools were identified from a list generated from individuals representing very different backgrounds.

First, a team of graduate educational technology students was encouraged to apprentice at the Faculty Center for Instructional Technology. The students' task was to experiment with proven technologies endorsed by the Center in order to create a prototype design model consistent with the objectives of the course. Second, technical teams at the faculty and university level were asked to provide input on the kind(s) of platforms and hardware and software configurations that met course criteria and that were affordable and easy to maintain. Third, the Dean and other key administrators were asked to show their commitment by providing the necessary resources and helping to set production deadlines. The author coordinated the interaction between these parties and gradually refined his own selection of mediating tools as the feasibility of their fit with the different learning activities became apparent.

The rationale underlying these choices is summarized in Table 3.4. Print materials include an academic text that provides the declarative knowledge and concepts necessary to understand basic topics in personal finance. Sixteen articles written by practitioners with prevailing views from the media and industry were selected to complement the text. The choice of print ranked high with respect to reliability, portability, and what most learners are accustomed to.

Table 3.4

Mediating Tools

Print
- Academic text
- Articles from practitioners
- Supplements (Newspaper, Bond Rating text, Internet Guide)

Videos
- Introductory videos profiling practitioners
- Canadian Broadcasting Corporation programs from the "National"; Venture and "Marketplace" series

Web-based tools

Practice Tests	Conceptual Highlights	Course Management
- Pre-Tests	- Facts of Life	- Bulletin boards
- Review Exercises	- Stop and Think	- Glossary
- Mini-Cases	- Axioms	- Calendar
- Post-Tests	- Websites	- Grades
		- Help Desk
		- Free Software

Communication Software
- Discussion Forum
- "Expert" folders (Instructors and Practitioners
- Chat features
- Posting of work in public folders

The video series was selected (and produced) primarily to humanize the web environment. As mentioned earlier, it also represents part of the expertise model. Videos provide a variety of contexts, a point emphasized by Duffy and Jonassen (1991) and it is central to the exemplary learning program devised by the Cognition and Technology Group at Vanderbilt (1992). For *Personal Finance*, sixteen five-minute "introductory" videos present conversations between the author and selected experts who highlight important areas in the chapter. They provide examples, make analogies, and share personal experiences. These videos not only help the learner to discriminate among personal finance issues, but also demonstrate expert role models in action. The majority of these experts have graduated from this University, and hold prominent positions in Banks, Accounting Firms, Insurance companies, Bond-Rating firms, and Mutual Fund Companies (see Figure 3.3)

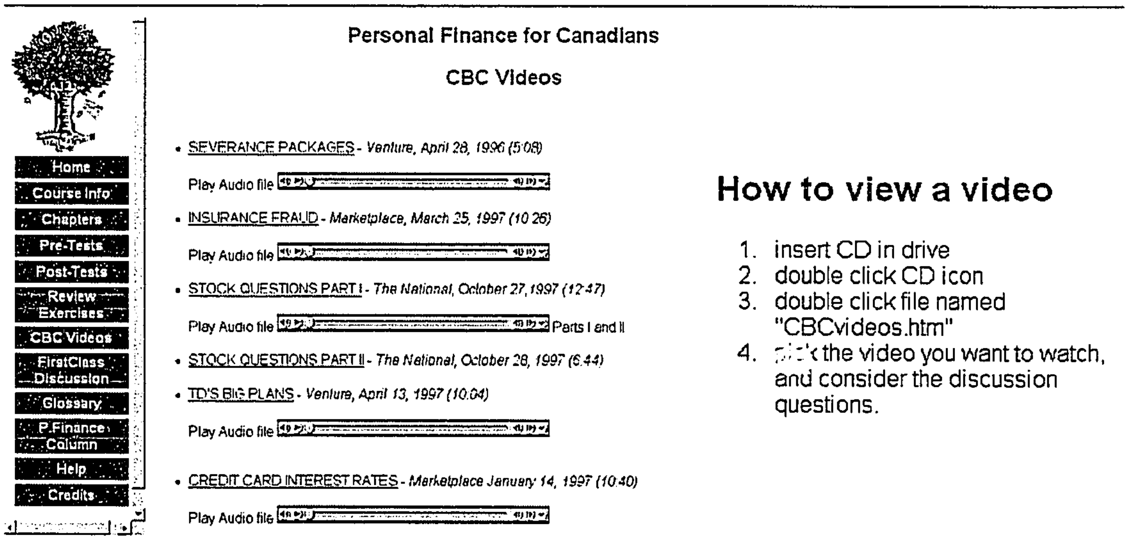
Figure 3.3

Experts in Action Videos

In addition, digital rights were secured for a series of programs from the Canadian Broadcasting Corporation (CBC). These programs feature documentaries from well-known national programs such as "Venture", "Marketplace", and "The National." Each program includes a series of discussion questions that are meant to elicit opinions and reactions from the learner. (see Figure 3.4)

Figure 3.4

CBC Videos



A brief introduction to each video was provided, which identified the issues that would be covered in the video and provided a context for applications that might be appropriate for the learner. Video topics were referenced to appropriate chapter readings and several questions for discussion were provided (see Figure 3.5)

Figure 3.5

CBC Videos - Questions

Personal Finance for Canadians

CBC Videos

SEVERANCE PACKAGES - *Venture, April 28, 1996 (5:08)*

Lay offs and downsizing are two terms heard all too frequently in the 1900s. Pink slips, the term used to illustrate redundancy in both the corporate and government sectors were handed out to countless thousands of Canadians. Many of these people were too young to retire and didn't want too. They felt they still had some productive years left and wanted to choose the date of their retirement themselves. Forced idleness was not what they wanted but what could they do? The job market was suddenly awash with the resumés of talented, experienced people all seeking a job in a greatly reduced job pool.

This tape looks at the issue of severance packages when those who receive them are not ready to retire. It looks at the few alternatives available and discusses the possibility of starting a business.

The episode will help focus students to the need to plan your life and not jump even when something serious happens to you like losing a job.

Play Video - (Chapters 4 & 7)

Discussion Questions:

- What happened to the Canadian economy to cause this tragedy?
- How many men and women were affected?
- Why is it difficult for mature people to find jobs?
- What should you do when you receive a severance notice and don't want to retire?
- Can everyone in this situation start a business?
- What should you do with the severance package?
- What are the expectations for severance packages in the future?
- What kind of planning should the persons undertake?
- Are you prepared for an emergency like these situations?

For those who are considering starting a business after receiving a severance package, the tape gives the following guiding questions:

The Web Interface

Learner control issues were discussed in chapter 2. On one end of the continuum is a preference for discovery learning, and on the other end is the desire for structure and direction (Shute and Psotka, 1994). Given the introductory level of *Personal Finance* and the variety of learning resources available, the instructor and practitioners felt that guidance was appropriate. This guidance was also meant to expose the learner to the full range of tools designed for this course and navigate seamlessly from one point to another. Accordingly, a sequence of learning activities that could be applied to each topic was suggested. (see Figure 3.6).

The first step in the sequence is to take a "Pre-Test" on the topic selected. This is meant to provide a rough indication of the learner's prior knowledge, so that s/he spends more (or) less time on the range of learning activities available. The Pre-Test contains True/False and Multiple Choice questions and has immediate feedback opportunities, including a link to text material for the concept being tested (see Figure 3.7).

Figure 3.7

Example of a Question in a Pre-Test

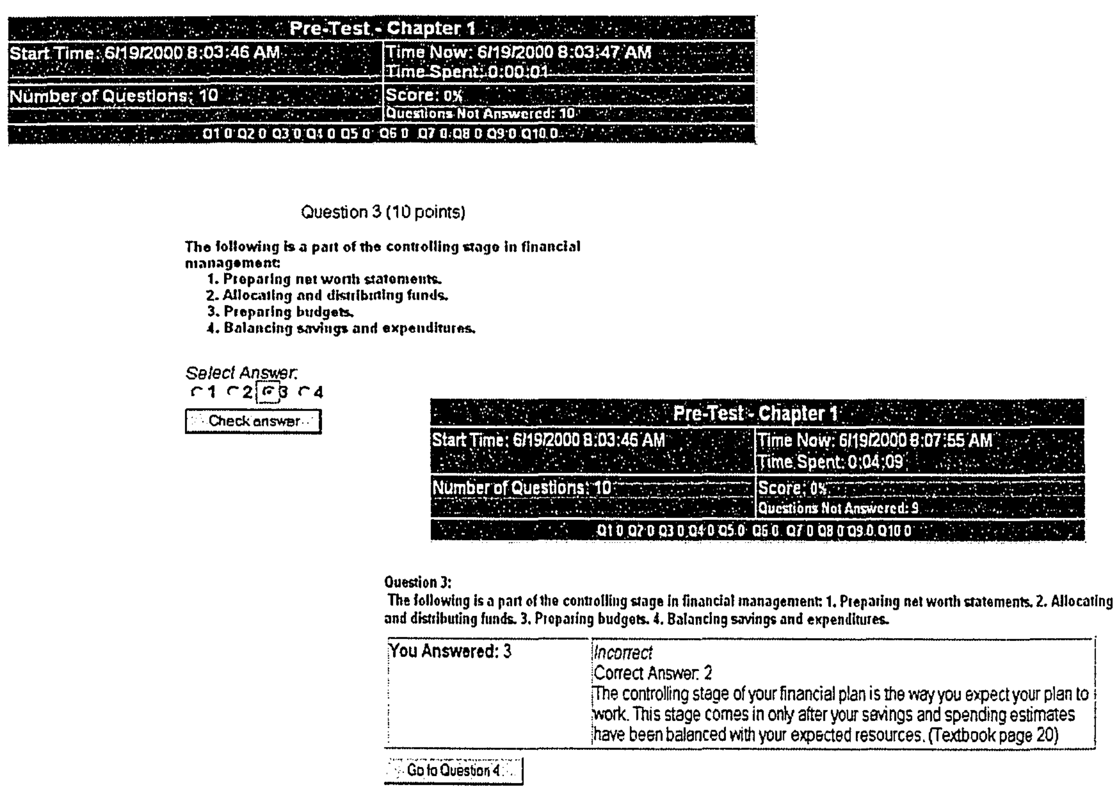
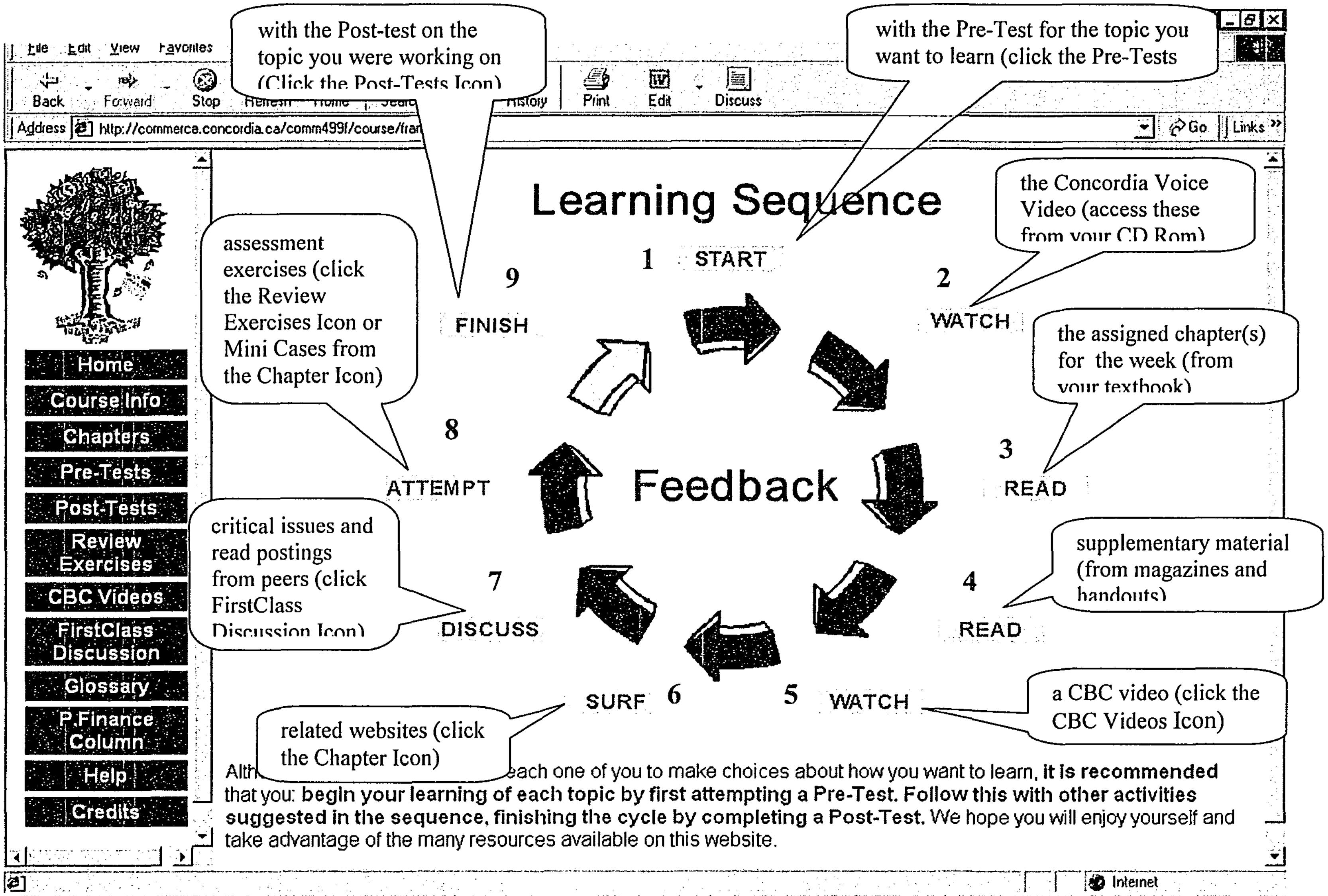


Figure 3.6

Home Page Note: Information presented around the sequence is embedded within the buttons.



The next four steps suggest that the learner (a) watch the short video highlighting various aspects of the topic in question, (b) read the assigned chapter, (c) read additional material from assigned articles and (d) watch the full documentary (CBC) video related to the topic. With this background, the learner is encouraged to browse through the seven buttons created in standard shell format for *each* chapter. These shells are illustrated in Figure 3.8

Figure 3.8

Seven Buttons for each of the 14 Topics in the Course

The title of most of the buttons above are self explanatory. The buttons are: (i) Objectives (learning goals), (ii) Facts of Life (factual information on applications), (iii) Stop and Think (prompts to elicit reflection), (iv) Cases (situations followed by brief questions and suggested answers), (v) Axioms (conceptual highlights), (vi) Websites (extensive list of sites worldwide), and (vii) Worksheet (simulations to create plans, budgets, statements, etc.). Some of these are illustrated in Figures 3.9 and 3.10.

While buttons such as "Facts of Life", "Stop and Think" and especially "Websites" provide a lot of information, surfing these often leads to other "interesting" Websites. As such, the main control buttons on the left-hand side of the screen are always present to allow the learner to return to the main course Website. Furthermore, other buttons in the chapter shell (for example, building a worksheet or practicing mini-cases) emphasize the importance of learning by doing. For Mini-Cases, feedback was provided on demand so that participants could compare their responses with those suggested by the author. This feedback was referenced to sections in the textbook to provide a broader context for understanding issues arising from the case.

Figure 3.9

Selected Buttons from the Chapter Shell (I)

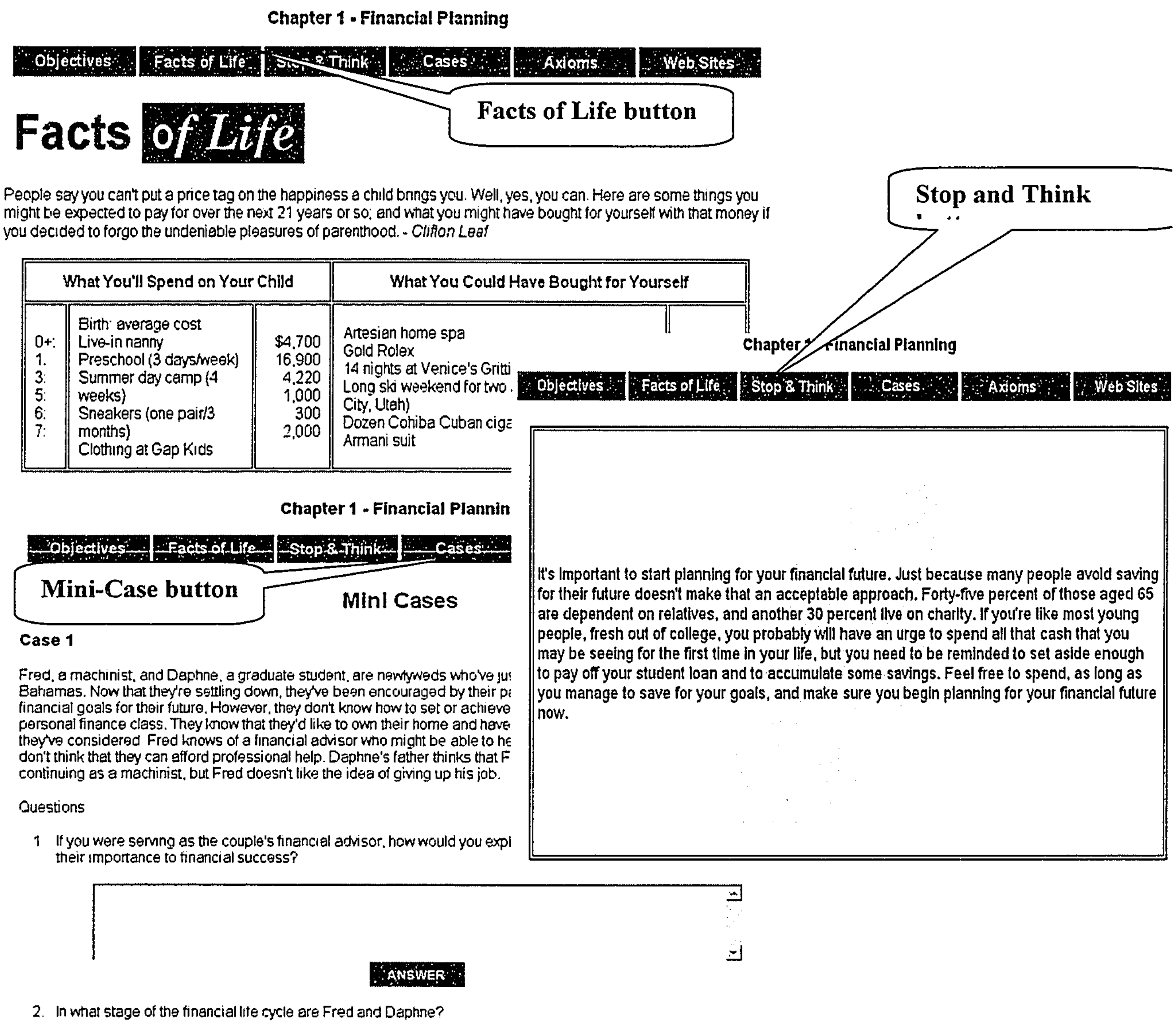
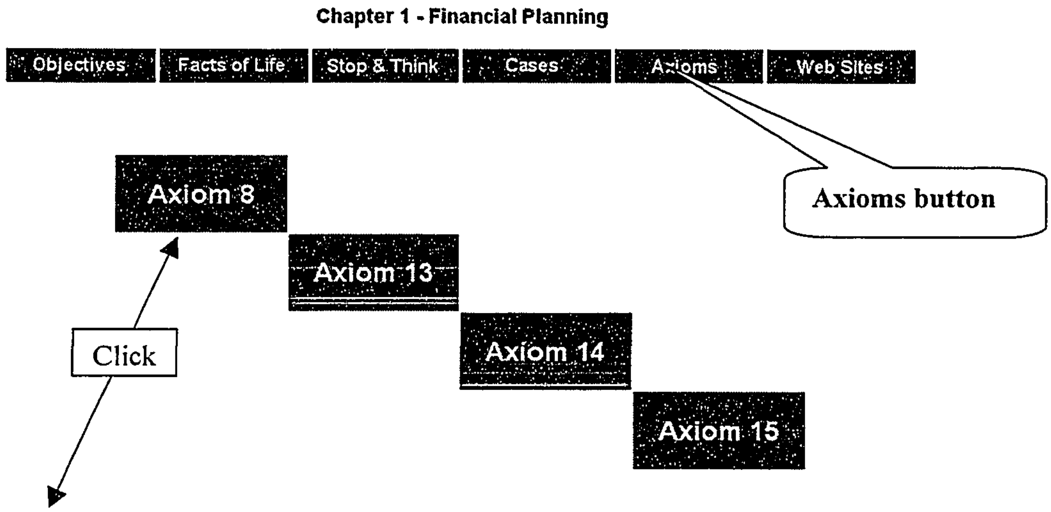


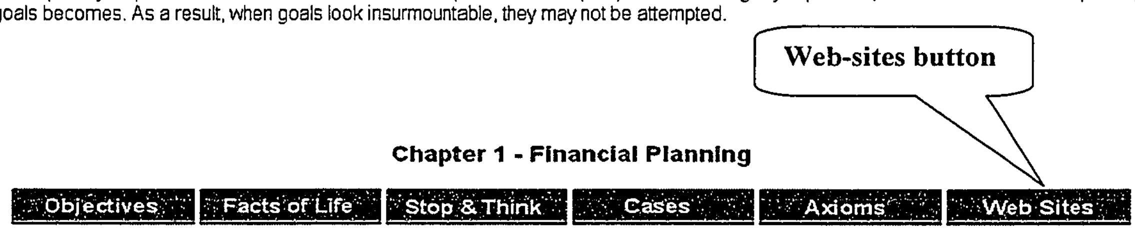
Figure 3.10

Selected Buttons from the Chapter Shell (II)



Axiom 8: Nothing Happens Without a Plan--Even (or Especially) a Simple Plan

Most people spend more time planning their summer vacation than they do planning their financial future. It's incredibly easy to avoid thinking about retirement, to avoid just thinking about how you're going to pay for your children's education, and to avoid thinking--at least when it comes to unpleasantries such as tightening your financial belt and saving money. We began this book with the statement that it is easier to spend than to save. We can go beyond even that and say it is easier to think about how you're going to spend your money than it is to think about how you're going to save your money. However, if you're like most people, you can probably spend money without thinking about it, but you can't save money without thinking about it. That's the problem. Saving isn't a natural event. It must be planned. Unfortunately, by the same token, planning isn't natural either. For that reason, although an elaborate, complicated plan might be ideal, in general it never comes to fruition. Start off with a modest, uncomplicated financial plan. Once the discipline of saving becomes second nature, or at least accepted behavior, modify and expand your plan. The bottom line is that a financial plan cannot be postponed. The longer you put it off, the more difficult accomplishing goals becomes. As a result, when goals look insurmountable, they may not be attempted.



Personal Finance on the Web

Each of the following Web sites provides high-quality links to many other Internet resources.

Dictionary - A dictionary of financial terms.

FinanCenter - Provides information and calculations about budgeting, automobiles, housing, savings, investments and credit.

Canada WealthNet - An index of Canadian financial and investment news and a list of advisors accessible via the Net.

Canadian Financial Network - Provides a collection of over 6,000 international online personal finance resources as well as research reports.

Quicken Financial Network - A Canadian site provided by the developers of the popular software programs Quicken and QuickTax that encompasses a financial fitness test, expert advice, investment tracking, and other financial help.

RetireWeb - A site that emphasizes planning for retirement, no matter what your life cycle stage.

About.com - Gives an index of excellent personal finance links including budgets and planning.

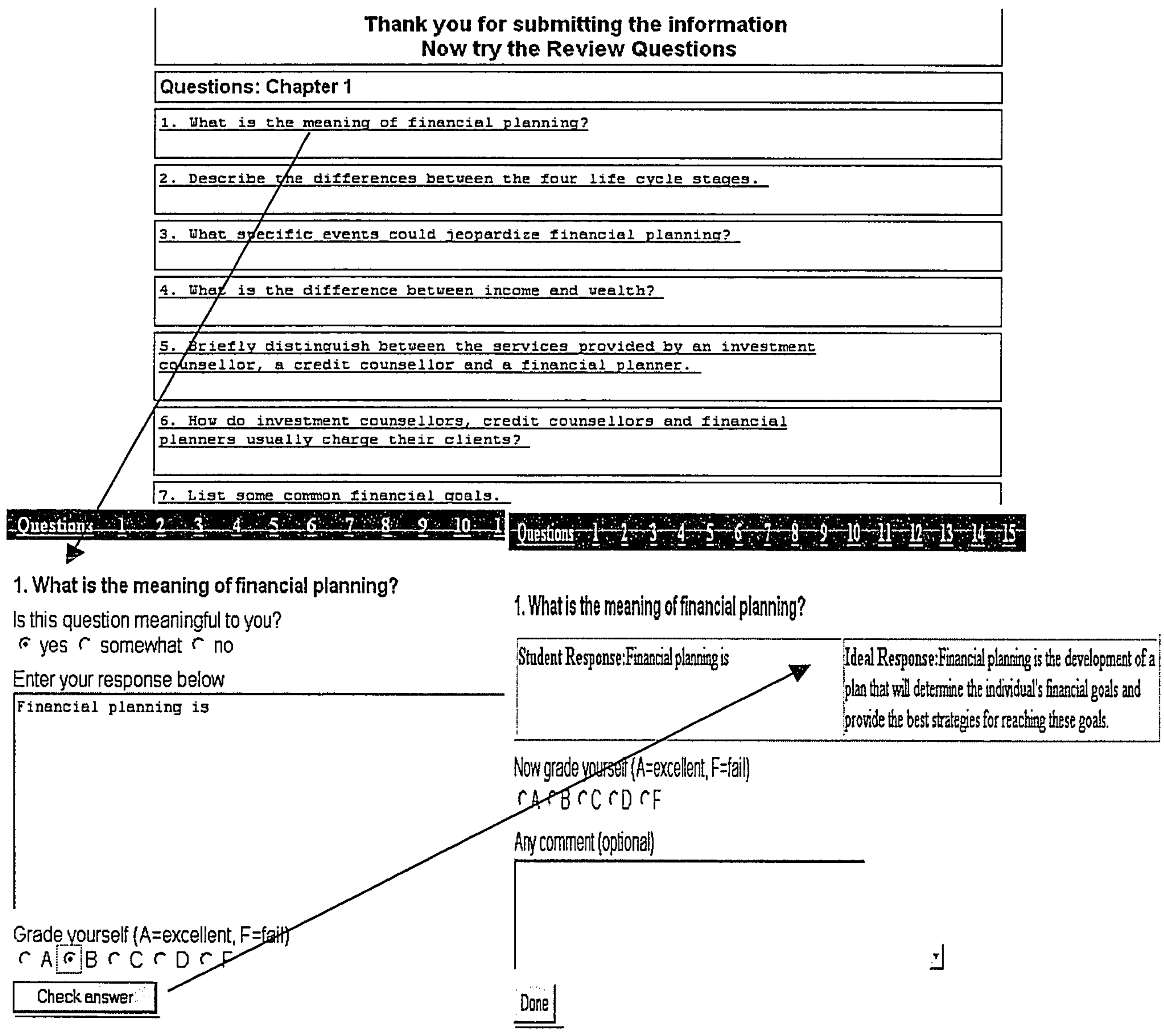
Scotia Bank - A fully searchable site with significant information on most facets of financial planning.

TPA Investment Planning - An independent investment fund dealer who addresses common myths associated with financial planning and offers valuable information.

Once learners have browsed thorough these seven buttons, they are encouraged to attempt to answer more difficult, open-ended questions relating to the topic they have selected. These questions have been labelled "Review Exercises." They show on the sixth button on the control panel (see Figure 3.6). The review exercises test for both declarative and higher-order knowledge, and once again, immediate feedback is available. (see Figure 3.11)

Figure 3.11

Example from Review Exercises

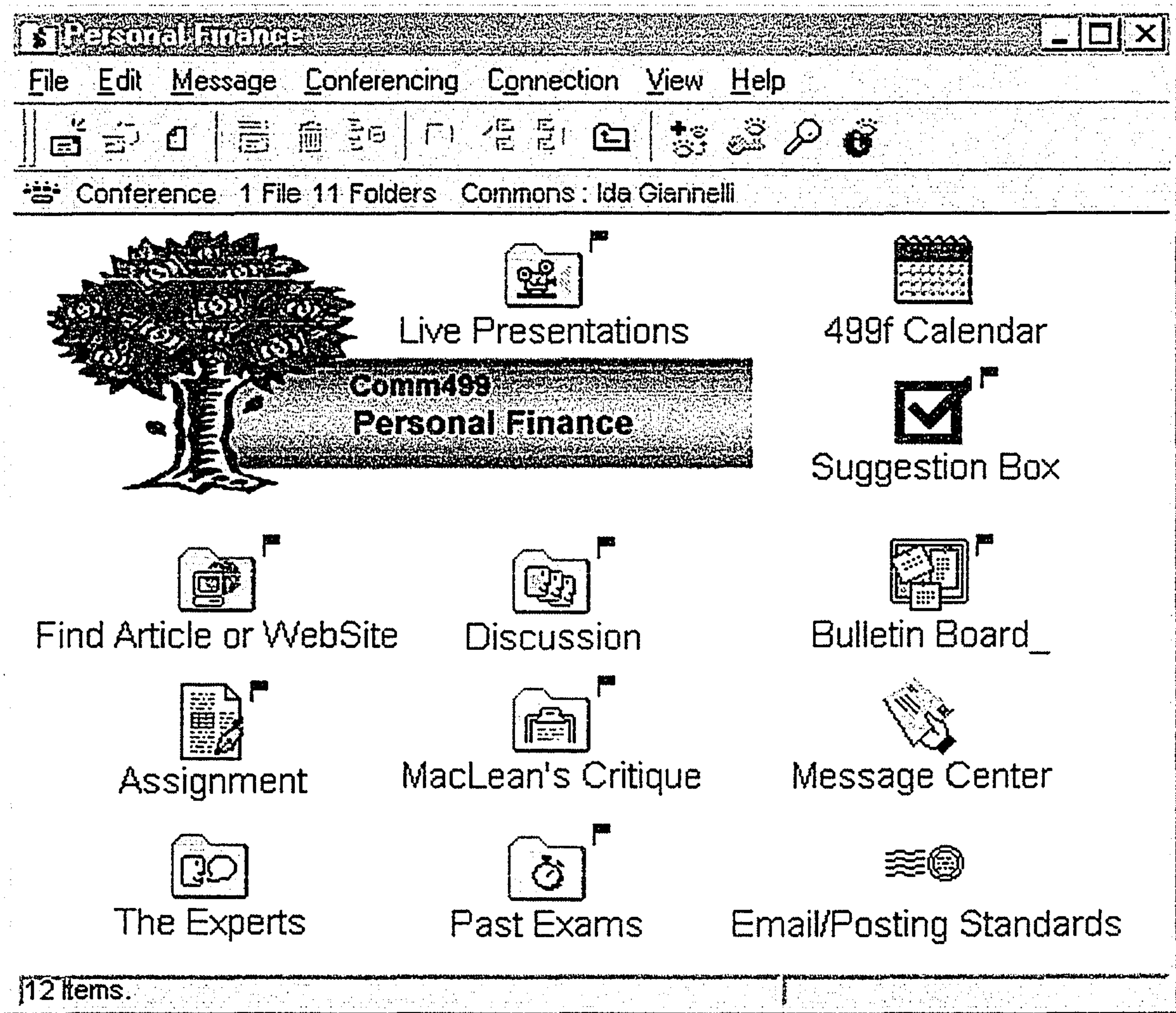


Thus, the Web-site provides numerous opportunities for practice, ranging from short Pre-Tests to more sophisticated worksheet simulations, mini-cases, and review exercises. These use various interactive formats and reflect different degrees of difficulty. They have been designed by the author to improve what Spiro, Feltovich Jacobson, and Coulson, (1991) refer to as cognitive flexibility. All testing material provide immediate feedback, including ideal answers, score summaries, time spent, etc. Tests have also been arranged sequentially, so that the learner begins with a Pre-Test, then attempts review exercises and cases, and ends with a Post-Test.

Conceptual highlights and other sources of information provide additional material to the *Personal Finance* Website. The learner is prompted to discover axioms, principles, facts, and the inter-relationships between topics. These inter-relationships exploit the linking capabilities of the web and help the learner to map out bigger pictures than those traditionally provided in a single chapter format.

Finally, the last step in the suggested sequence involves FirstClass communication software. This tool which enables messaging via e-mail and posting of work-in-progress and completed assignments. It also provides access to experts on specific decision topics in personal finance (see Figure 3.12). Instead of highlighting features of communication software that learners can take advantage of (which is what many courses tend to do), activities have been purposefully designed to ensure that the learner becomes immersed in the subject matter. In addition, the instructional strategy underlying communication activities is meant to be consistent with all components of the course design. According to Miller and Miller (1999) pedagogical design "communicates information that shapes students' experiences, including expectations about the purpose of learning, the depth of their reflection and understanding, the level of their participation, the degree of learner control, and the students' perceptions of the instructor's role." (p. 4).

Figure 3.12
Communication Software: FirstClass™



In the case of many institutions, communication software is sufficient in and of itself for hosting all of the learning activities conducted online. There are opportunities to communicate by email, chat, collaborate, critique, etc., as there is the ability to see work-in-progress. As evident from the descriptions of folders in Figure 3.12, this multi-platform communication interface provides a progress report on learning activities for both the teacher and the learner. Each folder can contain as many levels (sub-folders) as desired. For example, the "MacLeans Critique" has five sub-folders entitled “Guidelines”, “Draft”, “Peer Feedback”, “Exemplary Work”, and “Final Report.” The guidelines remind the students of course expectations, and criteria for assessment (see Table 3.5).

Table 3.5

Guidelines for the Critique

You will be assigned an article from The Maclean's Guide to Personal Finance (available from the Bookstore). Post a working copy or draft of your critique to the "Draft" folder. Begin your draft with the title and full citation followed by one summary paragraph that highlights the main points and context of the article. The remainder of your critique should contain your opinions, reactions and evaluation of the article. Do not repeat what has already been said. Your grade is based on identifying concepts (or the lack of them) in the article. Write a brief summary of what you have read which should address the following:

- What did you (or did you not) get out of reading the article?
- Does the article reach its intended audience? Who might they be?
- What are the major strengths and weakness of the article?
- What is missing given the content and topic?
- What parts of the article relate to specific topics and concepts in the course?
- How can it be improved?

It is strongly recommended that you read other articles on the subject area to enrich your critique. Attach a bibliography containing references and citations from these sources. Once you have received feedback from another group, incorporate changes from the feedback report, refine your draft by revisiting the criteria for the article critique and post your final copy.

Feedback

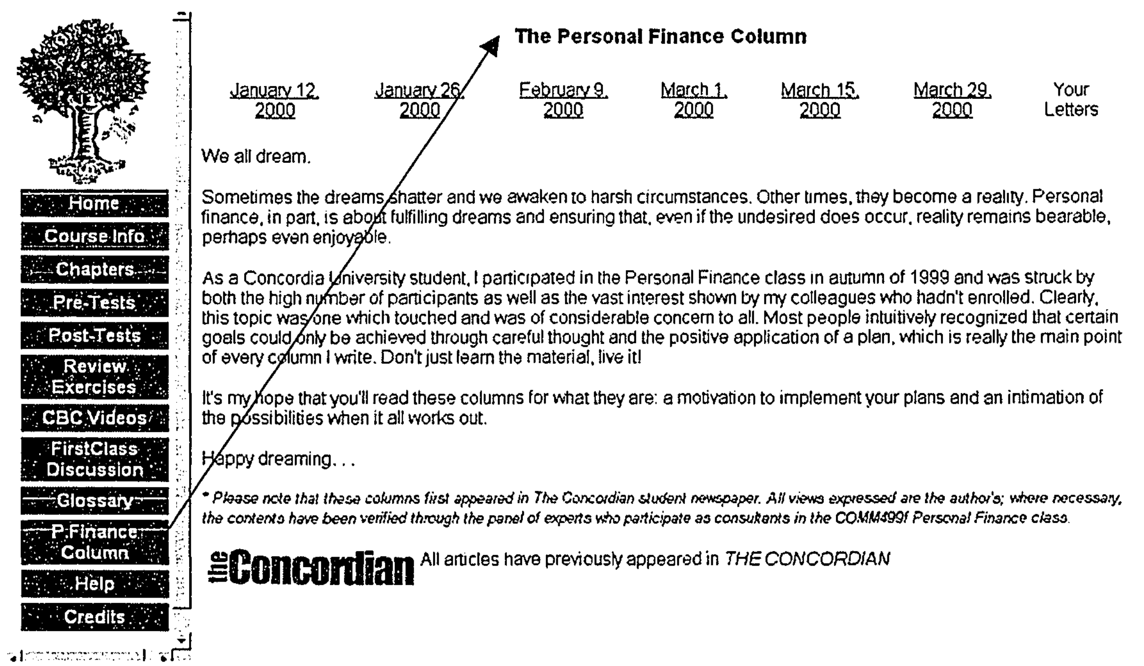
Each group will provide feedback to one other group. The purpose of this assignment is to provide constructive criticism to your peers that will help them to improve their draft. The maximum length is 1 typed page. Your feedback should address the following:

- Suggest three things that would significantly improve the draft
- Is the draft conforming to the criteria specified? Main point(s) been made?
- Provide at least 2 reference(s) that would add to the quality of the draft.

The “Exemplary Work” folder showcases student work that is recognized by the instructor and practitioners as outstanding. This work is a valuable means of modelling what is regarded as desirable outcomes for the course. For example, participants were encouraged to write to the campus student newspaper “*The Concordian*.” The Editors of the *Concordian* agreed to include a bi-weekly column on issues in personal finance that would be of interest to the entire university community. Participants in the course were encouraged to write short letters to the editor or pose questions to the columnist. Occasionally their letters or comments would be published in the paper. A majority of participants indicated high levels of motivation and satisfaction in creating original work that could be showcased for their peers and the community. Access to the column and their letters was facilitated by clicking on the "P.Finance Column" button (see Figure 3.13)

Figure 3.13

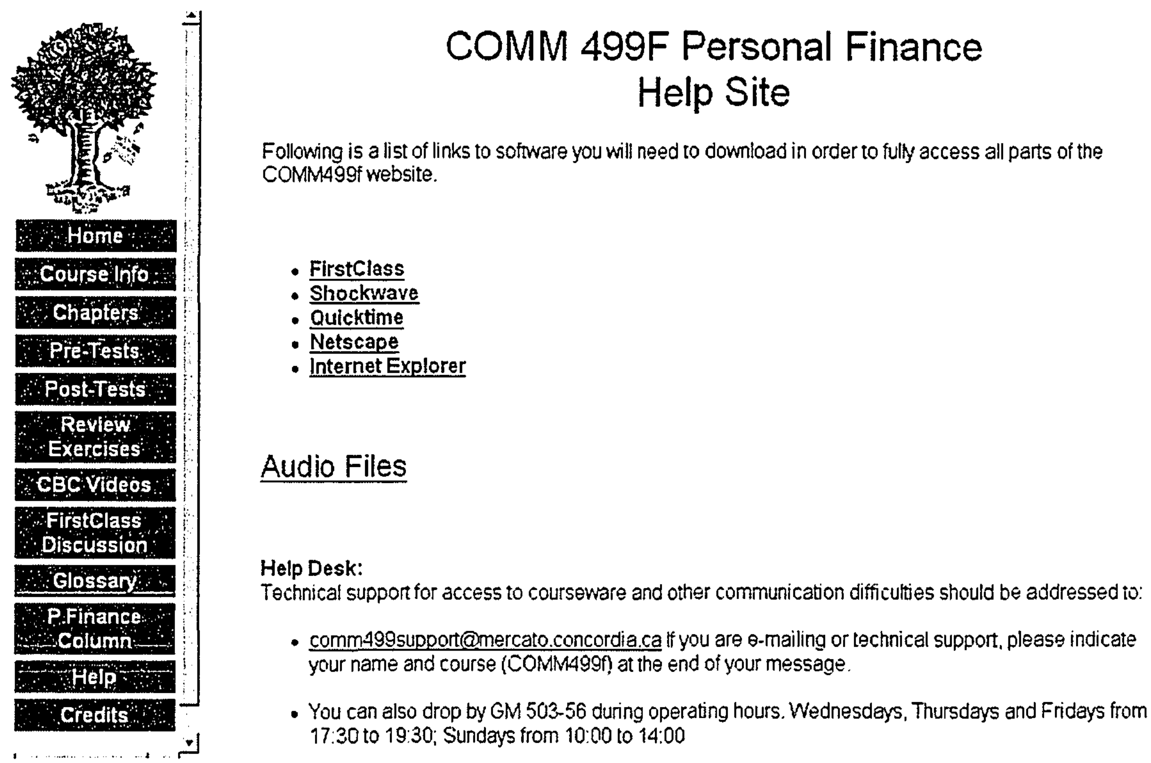
<u>The Personal Finance Column</u>



A variety of course management tools were designed to facilitate learning and to assist with the administrative aspects of the course. These include a grade-book, which is updated as students submit the required work for the course and a glossary to useful terms. In addition, the "Help Desk" offers support services, enables the downloading of software, and references frequently asked questions. (see Figure 3.14).

Figure 3.14

Help-Desk



Summary

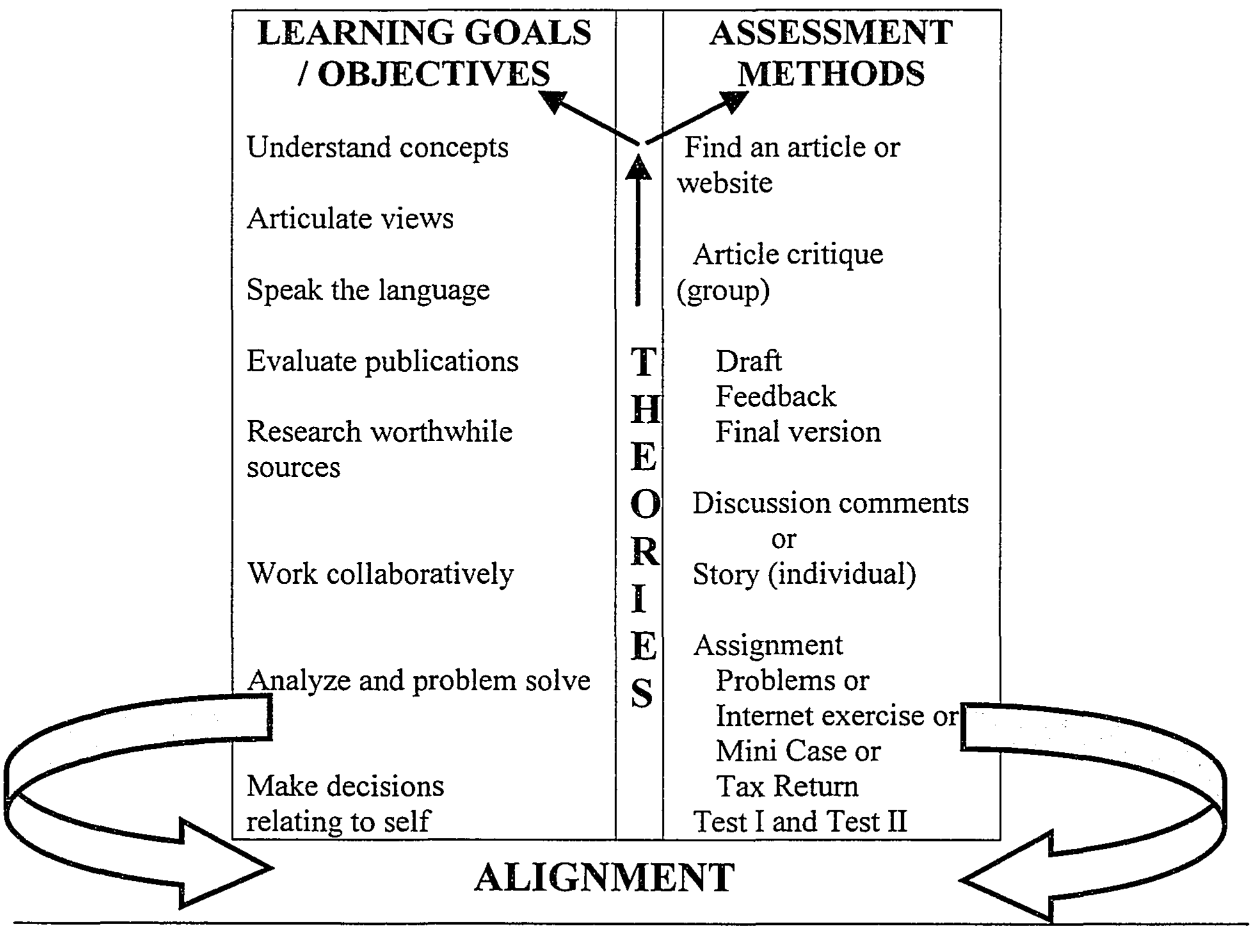
This chapter began with a discussion of how pedagogical philosophy based on paradigms of knowledge impacts upon course design and development. It emphasized that course developers using explicit theories of learning must simultaneously consider the intersection of these theories with technology and educational practice.

An instructional design framework for teaching Personal Finance on the web followed. Using a constructivist approach, attributes of an open-learning model are used to derive learning outcomes, teaching/learning activities, and assessment methods. The importance of constructive alignment between these different design components is emphasised (Biggs, 1999). The components become inextricably linked, so that the course becomes greater than the sum of its parts. In the case of the alignment between objectives, activities, and assessment tasks, as well as the cognitive tools that mediate between these components is illustrated in Figure 3.15. In addition to the theoretical grounding of each design component, the chapter highlights pragmatic concerns that arise as operational decisions are made at each stage of course development.

The final section covered technology integration and the rationale behind the selection of mediating tools. These tools reflect a mixture of traditional as well as state-of-the-art approaches. The choices were also constrained by resource and time limitations, although relatively few compromises were made on either score. A variety of print-based, multimedia and interactive web-based tools were selected according to how they could best enable the learner to attain the learning goals set for the course. Again, an overarching constructivist philosophy guided the ultimate purpose that these tools were meant to serve – to raise the intellectual, social and ethical standards of a community of learners by empowering them to question, participate, and practice authentic activities in personal finance.

Figure 3.15

Alignment of Design Components in Personal Finance



CHAPTER 4
METHOD
Participants

The participants in this study were 338 students enrolled in the Personal Finance course at a Canadian University during the fall 1999 semester. The initial registration for the course was 373 students. After the deadline for academic withdrawal, (the fourth week of a thirteen week semester), 338 students were still registered in the course, signifying an attrition rate of 9%. Personal Finance is the first web-based course offered by the business faculty as a 3-credit elective at the undergraduate level, but may be taken by part-time, full-time, and independent students regardless of their faculty or background. The course does not have any pre-requisites. Except for a face-to-face orientation session at the start of the term and an in-person final exam, there is no classroom instruction.

Materials and Collection Procedures

All participants were required to own or have access to the minimum hardware and software versions specified in Table 4.1. The software was licensed by the Faculty and could be downloaded at no cost from the course website. Participants were advised not to rely on the lab facilities at the university campus due to their heavy use and limited hours of operation, although lab accounts were created for each participant.

Table 4.1

Minimum Hardware and Software Requirements

Hardware:
- 640 x 480, 256-color monitor (recommended: 800 x 600)
- 8 MB RAM with windows 3.1 (5 MB available); or 16 MB for Pentium with Windows 95/NT (10 MB available) or,
- Mac requirements: 68040 33 MHz, 8MB RAM (5 MB available) with System 7.1 or higher; or PowerPC, 16 RAM MB (8 MB available) with system 7.5 or higher.
- A modem or connection with a network and a web browser (eg. Netscape 3.0 or above)

Software:
- FirstClass™
- Quicktime
- Shockwave

During the face-to-face orientation session, all participants voluntarily agreed to sign a letter that (a) stated the purpose of the study, (b) gave their informed consent, and (c) explained the provision for their voluntary termination at any point during the course of study (see Appendix B). The participants also completed a paper-based survey (n = 290) with the following four sections: (a) Learner Profile, (b) Learner Motivation, (c) Current Knowledge, and (d) Tool Use (see Appendix C).

The survey was pilot-tested with educational technology graduates (n = 5) completing an internship in the Faculty's Center for Instructional Technology, and it was circulated to faculty who were experienced in the design of survey questionnaires (n = 4), during the summer preceding the delivery of the course. Since no problems were encountered, an identical survey (see Appendix D) was administered during the end of the semester (n = 307) to gauge a time-series dimension of survey items. While these surveys gathered pre and post impressions of participants' responses with respect to the four sections listed above, another survey was administered electronically during the middle of the semester to gather data on the participants' (n = 242) proficiency with online tools (see Appendix E). Finally, a summative evaluation of the course was made available electronically at the end of the semester (see Appendix F).

Personal Finance is a Web-based course that seamlessly integrates three different software applications. These applications were selected based on features that promoted practice opportunities for the learner, their ease of use, technical support, and their data collection capabilities. The applications include: (a) FirstClass Software™, selected mainly for communication purposes and for posting work-in-progress, (b) WebCT, selected for practice tests designed as true/false and multiple choice questions as well as other features that support course management, and (c) File Maker Pro, selected for practice tests designed as open-ended questions as well as for administering surveys. In addition, HTML programming was used to construct a shell that includes standard icons for each topic as well as other resources such as a glossary, help desk and other course related information (see Table 4.2).

Table 4.2

Brief Descriptions of Software Applications

FirstClass is a communication and collaboration software product known for its cross-platform usability, multi-client login capability, scalability and ease of administration. With tight integration of communication (email, Internet and Intranet), collaboration and time-management tools, FirstClass is a cost-effective solution for building online communities. More details are available at http://www.firstclass.com/.

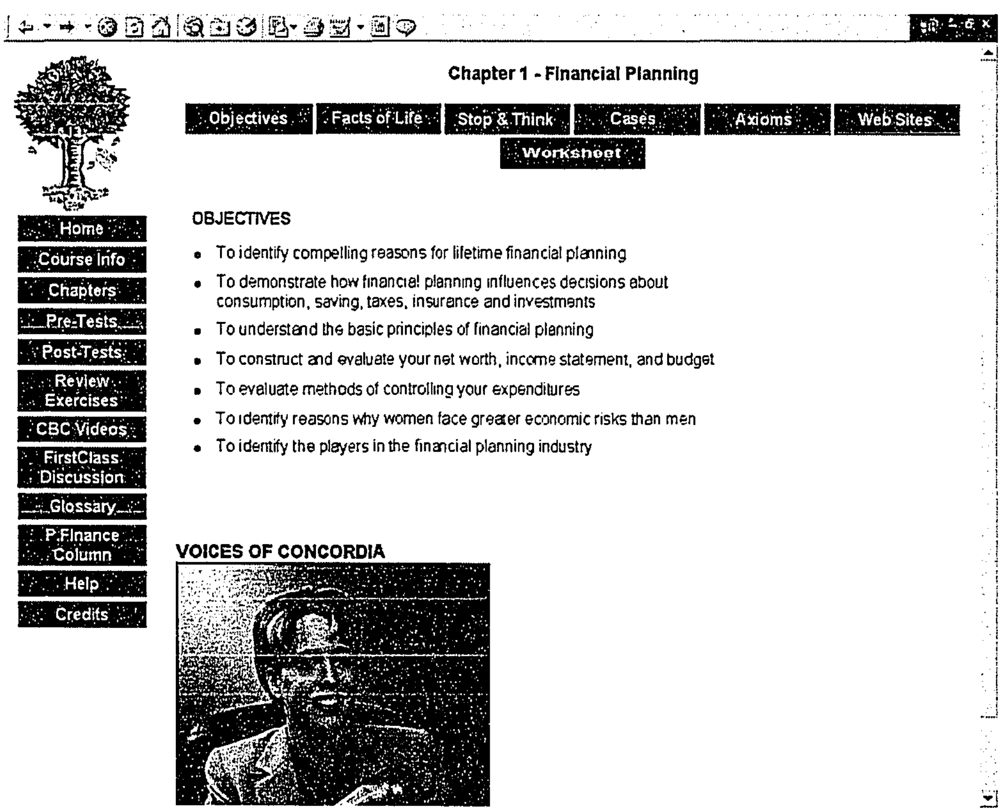
WebCT provides publishers, instructors, students and administrators with the ability to create and manage Web-enhanced courses using tools such as Bulletin Boards, Course e-mail, Chat Rooms, content shells, etc. More details are available at http://www.webct.com/ .

FileMaker is a database management program that supports web publishing. It allows users to automatically render database layouts on the Internet. More details are available at http://www.filemaker.com/.

Fourteen topics were selected for the course. Figure 4.1 depicts the shell covering the topic of Financial Planning. The top of the screen displays the seven buttons linked to material specific to this topic. The buttons on the left hand side of the screen display navigation to the major segments of this course including Pre-Test, Post-Test, Review Exercises, video, and FirstClass™ which were used to gather data.

Figure 4.1

HTML Shell for a Course Topic



Ongoing survey data were gathered electronically each time a participant attempted "Pre-Tests" and "Post-Tests." Fourteen Pre and Post Tests, each consisting of 10 true/false and multiple-choice questions, were designed. These tests provided a starting and ending point for learning material for each topic in the course. They also provided an opportunity to chart the frequency of attempts and average scores earned by participants.

Fourteen topics were selected for the course. As mentioned in Chapter 3, for each of these topics, a title bar on the top of the screen (Figure 4.2) displays seven buttons. Data was tracked and collected from *Facts of Life* (factual information on applications), *Stop and Think* (prompts to elicit reflection), *Cases* (situations followed by brief questions and suggested answers), and *Axioms* (conceptual highlights).

Figure 4.2

Seven Buttons for each of the 14 Topics in the Course

Data were also collected electronically each time a participant volunteered to respond to a dozen short questions that preceded "Review Exercises" for each topic in the course (see Appendix G). These questions were primarily designed to solicit information on the frequency of tool use by participants, as well as to provide them with an opportunity to comment on chapter material.

In addition, two types of videos were accessible for each topic. The first, entitled "Voices", presents a short 5-minute interview with an expert who provides her/his insight on different aspects of the topic. The second, entitled "CBC videos", presents full feature documentaries that had previously been broadcast on national television. Participants were asked to record whether they watched these videos each time they reviewed questions on a given topic for the course.

Finally, sub-folders were created in a FirstClass™ window that provided a home for course activities (a) that were in progress, and (b) that represented the final products of participants' work that would be assessed for grades (see Appendix H). This window could be accessed directly from the course website by clicking on the "First-Class Discussion" icon seen on the control panel. The collection of data is summarized in Table 4.3.

Table 4.3

Summary of Materials and Collection Procedures

Instrument	Date	Type	Description	Appendix
Consent Form	10/09/99	Paper-based	Permission to release information for research	B
Survey I	10/09/99	Paper-based	Learner profile; motivation level, current knowledge and tool use	C
Survey II	05/11/99	Online	Proficiency with online tools	E
Survey III	10/12/99	Paper-based	Same as Survey I; repeated to gather a time series dimension of the learner's profile	D
Survey IV	10/12/99	Online	Summative course evaluation	F
File Maker Pro	Entire semester	Online	Ongoing responses to tool use and open-ended questions	G
WebCT	Entire semester	Online	Ongoing attempts of Pre Tests and Post Tests	
FirstClass™	Entire semester	Online	Discussion comments, Stories, Critique, Feedback, Test I and Assignment	H
Test II	End of Semester	Paper-based	Final assessment written in person	

Although each software application has significant data-gathering capabilities, this study is limited by the quality of data tracking features accompanying each platform and by limitations arising from data extraction. For example, while File Maker Pro and FirstClass Software™ recorded the frequency of student logins and logouts, what actually occured online at every moment could not be determined. In addition, students self-reported on the number of cases they practiced, whether they watched videos corresponding to specific topics, whether they browsed through the websites listed for each topic, etc. These data are recorded in File Maker Pro. As mentioned in the previous section, participants were prompted to systematically respond to questions about tool use as they proceed from one topic to another.

However, there are limitations with respect to the reliability of self-reported data. As well, WebCT provides the frequency of Pre/Post tests practiced and scores obtained by students on those tests, but does not provide any intelligent feedback on open-ended questions that are common to adaptive tutoring systems.

Data Set

The selection of variables is based on theoretical principles discussed in the literature review and on the instructional design choices outlined in Chapter 3. Three broad constructs were used to identify variables that influence learning. The first construct identified knowledge acquisition strategies typically employed by students. Since multiple sources of information from different technology platforms were available to acquire knowledge, the initial identification effort attempted to capture as many variables as possible. The second construct identifies the type of cognitive tools used by students in a variety of practice opportunities that support learning. The third construct attempts to capture artifacts of learning that are reflected in the various assessment components of the course.

The large number of participants and the variety of instruments used to gather data resulted in the initial selection of twenty-seven variables that were considered for model specification (see Table 4.4).

Table 4.5 presents items that were excluded from the analysis (a) because of incomplete data, (b) because they could not be related to the conceptualization of the model, or (c) because they could not be justified on theoretical grounds.

Table 4.4

Description of Variables Extracted from Various Platforms

Variable (and Abbreviation)	N	Description
From the File-Maker Pro Platform		
1. Virtual Attendance (VA)	339	Grade assigned according to the amount of time spent on the course website
2. Chapter (CHAPTER)	339	Total number of chapters read
3. Notes (NOTES)	339	Total number of times personalized notes were made
4. Video (VIDEO)	339	Total number of times videos were watched
5. Axioms (AXIOMS)	339	Total number of times *Axioms* were read
6. Facts (FACTS)	339	Total number of times *Facts* were read
7. MiniCases (MINICASE)	339	Total number of times *MiniCases* were attempted
8. Proficiency (PROFIC)	241	Summative measure of overall proficiency with online tools
9. Total time (TIMETOT)	336	Total number of hours recorded online
10. Logins (LOGINS)	336	Total number of times logged on to the course site
From the FirstClass™ Platform		
11. Article (ARTICLE)	312	Grade assigned to finding an article on the internet
12. Feedback (FEEDBACK)	328	Grade assigned for peer feedback on a draft assignment done in groups
13. Critique (CRITIQUE)	339	Grade assigned for assignment done in groups
14. Test I Part I (MIDTERM)	339	Grade assigned for True/False and Multiple Choice questions on the online test
15. Test I Part II (MIDTERM)	339	Grade assigned for open-ended questions on the online test
16. Comments (COMMSTOR)	339	Grade assigned for discussion threads posted online

Table 4.4 (Continued)

Description of Variables Extracted from Various Platforms

17. Story (COMMSTOR)	339	Grade assigned for short story posted online
18. Assignment (ASSIGN)	339	Grade assigned for term assignment posted online
19. Test II Part I (FINALEXA)	339	Grade assigned for True/False and Multiple Choice questions on the in-person test
20. Test II Part II (FINALEXA)	339	Grade assigned for open-ended questions for the in-person test
From the WebCT Platform		
21. Faculty (FACULTY)	336	Whether the participant is from the business faculty or enrolled in other programs
22. Bonus (BONUS)	339	Bonus marks for completing online practice questions in Pre/Post Tests and Review Exercises
23. Final Mark	339	Sum of all grades assigned
24. No. of Pre-logs (PRENUM)	339	Number of online pre-tests attempted
25. No. of Post-logs(POSTNUM)	339	Number of online post-tests attempted
26. Pre-test Score (PRESCORE)	326	Average score on online pre-tests
27. Post-test Score (POSTSCORE)	326	Average score on online post-tests

Note: Students had the choice of writing discussion threads or a story (variables 16 and 17)

Data from Surveys I, II, and IV were also excluded since these were anonymous. Only the summative question from Survey III, labelled *Proficiency* ("How would you rate your overall proficiency using online tools?") was included as a variable (item 8). All other data from Surveys I, II, III and IV were analyzed to provide additional findings and a broad context for the main research objectives of model development and specification, the results of which are presented in Chapter 5.

Table 4.5

Description of Data Items Excluded from Consideration

Item / description	Reason for exclusion
From the File-Maker Pro Platform	
Student comments regarding specific questions from each chapter	These comments were used to revise and improve the quality of questions for subsequent use
Familiarity with chapter	Low frequency of responses
Meaningfulness of questions in Review Exercises	These comments were solicited to improve the quality of questions for subsequent use
Self-grading	Unrelated to conceptualization of model development
From the FirstClass™ Platform	
Bulletin Board Comments	Relate mainly to course management issues and for revision of the course
Suggestion Box	Relate mainly to course management issues and for revision of the course
Questions and Answers from Experts	Low frequency of responses
From the WebCT Platform	
Average time spent per Pre/Post Test	Unrelated to conceptualization of model development
Number of questions answered per Pre/Post Test	Variables 24 and 25 were considered to be more appropriate

Procedures used to refine the data set in order to develop a measurement construct of learning are presented in Chapter 5. Results from statistical analysis are also presented.

CHAPTER 5

RESULTS

Introduction

In Chapter 2, the concepts of expertise, pedagogical-content knowledge, and self-regulation were selected from the literature given their impact and wide acceptance in cognitive science and instructional theories. These concepts were employed in Chapter 3. The design also attended to three distinct constructs that are common to effective instruction taking palce. These constructs can be regarded as core elements of effective designs and are labeled as (a) Knowledge Acquisition Strategies, (b) Practice Effects, and (c) Assessment Components.

These core elements constitute the Web-based instructional model proposed in this study. They also represent the principal design components for *Personal Finance* on the Web. For example, it was hypothesized that open learning environments that use the enabling qualities of the World Wide Web recognize that knowledge acquisition strategies need to be distributed. This distribution is present in the form of cognitive tools that support aspects of the learner's cognitive processes, or enhance their cognitive functions during thinking and problem solving (Lajoie, 2000; Jonassen and Reeves, 1996).

In addition, Practice Effects were emphasized as an essential component as it is clear from the expertise literature that experts know how to represent problems effectively and how to nurture participants through conditions of effective practice (Anderson, 1983). Practice effects also emphasize the importance of tasks that promote reflection and opportunities that allow the learner to attend to discrepancies. This suggests that conditions for effective practice must be embedded in the learning environment.

Finally, assessment components were considered critical, since these are inseparable from instruction in the sense that they provide indications of competence and development. Thus, the conceptualization of a Web based model based on these principal components, labeled as The Integrated Learning Model (ILM), are tested for validity and reliability, the results of which are reported in this chapter.

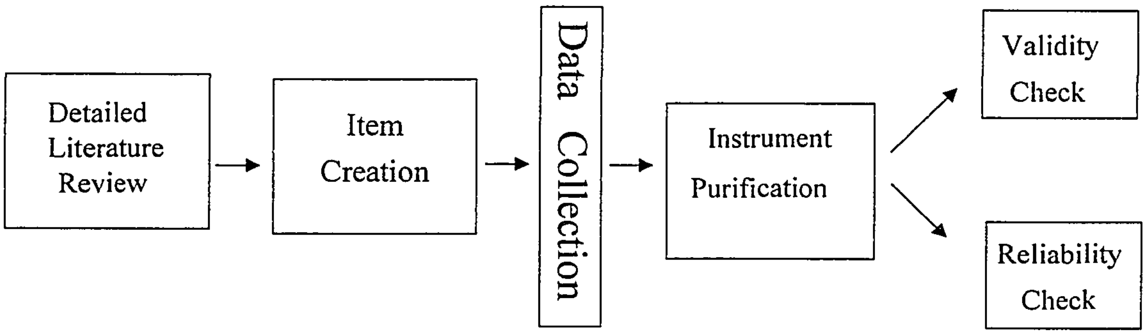
The first part of this chapter discusses the procedures that were used to develop a valid measurement instrument for capturing the latent construct underlying the design of *Personal Finance*. This construct is simply labelled "learning." Using a confirmatory approach, the causal processes under study are represented by a series of regression (or structural) equations, which are modelled pictorially to allow for a clearer conceptualization of the theory. Results of the hypothesized model are tested statistically in a simultaneous analysis of the entire system of variables to determine the extent to which it is consistent with the data (Byrne, 1994). The procedures for developing the instrument and the results of the goodness of fit tests are then presented. The second part of the chapter reports on the analysis of various anonymous survey instruments described in chapter 4. This analysis provides the context for interpreting the dimensions of learning reported in part one, and leads to several implications that are discussed in Chapter 6.

Technically, the development of a measurement instrument that captures a given construct involves "rules for assigning numbers to objects to represent quantities of attributes" (Nunnally, 1967, p. 2). The procedural rules for developing a measurement construct follows a rigorous framework that allows for the validation and potential replication of this design experiment. I have used Churchill's (1979) approach for developing "better measures" to conceptualize learning and define its dimensions. Churchill (1979) details the steps to follow in order to develop a valid and reliable measurement instrument. These steps are summarized in three stages and are presented in Figure 5.1.

During the first stage, a detailed examination of existing theoretical concepts, as well as an elaborate process of item creation, are implemented in order to build the measurement instrument. This is followed by the collection of data. During this stage, statistical analysis is performed, including exploratory factor analysis (EFA) to "purify" the instrument in order to obtain a final set of items. During the third stage, structure, validity and reliability checks are performed on these items using confirmatory statistical procedures. In addition, other components of the measurement model are tested in order to identify the potential influence of these variables. Finally, conclusions are drawn regarding the quality of the measurement model as well as other components identified as potential factors that may influence the construct.

Figure 5.1

Procedure for Developing a Measurement Construct



Exploratory Factor Analysis

Prior to the first Exploratory Factor Analysis (EFA), some variables were combined in order to obtain specific indicators. As students were given a choice to write either discussion comments or a short story, assessments on these components were combined to provide a unique variable called COMMSTOR. In addition, two new variables (MIDTERM and FINAL) were created by combining True/False, multiple choice, and open-ended questions on each exam. These new variables represent the un-weighted average of variables 14 and 15 for MIDTERM and 19 and 20 for FINAL, respectively. The data for each of these exams were considered unique in the sense that MIDTERM was conducted half way through the semester on-line, whereas FINAL was taken in-person by students at the end of the semester.

During the second stage, exploratory factor analysis (EFA) is recommended to refine the instrument in order to obtain a final set of items. In addition, EFA allows for the examination of patterns in the data which might suggest possible congruence between empirical results and the underlying theoretical support (Churchill, 1979; Stevens, 1986). EFA has been criticized if used by itself (Gould, 1981). But, if performed prior to a confirmatory factor analysis (CFA), it elaborates the optimal factorial structure that will be tested in the CFA. Items with poor psychometric properties can be identified and then deleted from the measurement instrument (Campbell, 1976; Churchill, 1979). Roehrich (1994) suggests that the identification of the optimal factorial structure is an iterative process in which successive EFA's are performed after each item's elimination until all the items and dimensions present reasonable psychometric properties. At this point, the factorial structure is tested using a CFA. Thus, the process employed in this study involves two steps. The first uses EFA, the second CFA.

Refining the Data Set

After the first EFA, the extracted numbers of factors, as well as the properties of the items, are examined and selection rules are applied. These rules are mainly based on the part of variance shared between an item and its construct. Rivard and Huff (1988) suggest a minimum value of 0.5 for this variance (that is, a loading above the 0.7 threshold). Kline (1994) considers factor loadings high if they are greater than 0.6 (the positive or negative sign being irrelevant). However, these strict rules can be relaxed somewhat on the condition that an item only loads on the dimension it is intended to measure and not on other constructs (Pedhazur and Pedhazur-Schmelkin, 1991). In addition, inter-item correlations among items measuring the same dimension should be high (Roehrich, 1994). These loadings play a major role in the interpretation of the factorial structure, and are examined after successive rotations and unsatisfactory items are deleted from the measurement instrument. In the case where two or more factors are extracted, rotation enhances the interpretability of the coefficients's matrix (Norusis, 1988). OBLIMIN rotation is used in this research because theory calls for correlated first order factors as well as a second order latent structure for learning (Long, 1983).

At the end of the purification process, the factorial structure (that is, the number and nature of dimensions) is examined. The appropriate number of factors to retain varies according to the selection criteria applied. The more popular criteria are (a) Kaiser-Guttman's arbitrary rule of eigenvalues with a score equal to or in excess of unity; (b) the interpretation of Scree-plot suggested by Cattell (1966), and (c) the cumulative percentage of variance extracted exceeding the 60% threshold recommended for social sciences (Hair, Anderson, Tatham, and Black, 1992).

The first EFA was performed using an OBLIMIN rotation. Results are presented in Table 5.1. Only loadings above the 0.25 level are presented in this table.

Table 5.1

Exploratory Factor Analysis on the Global Set of Items

	Principal Components				
	1	2	3	4	5
TIMETOT	.749				.420
LOGINS	.721				.256
PROFIC	.582				.320
VA	.450				.301
NOTES		-.884			
CHAPTE		-.878			
VIDEO		-.878			
AXIOMS		-.874			
FACTS		-.870			
MINICASE	-.281	-.516			.296
BONUS	.393	-.483			
FEEDBAC			-.685		
FACULTY			.666		.356
ARTICLE			-.593		
CRITIQU			-.576		
PRESCOR				-.881	
PRENU				-.866	
POSTSCO				-.765	
POSTNUM				-.764	
ASSIGN					.766
COMMSTO	.359				.702
MIDTERM					.668
FINALEXA					.526

Extraction Method: Principal Component
Rotation Method: Oblimin with Kaiser

As mentioned, the minimum rule of eigenvalue equal to one was applied. The eigenvalue of a factor is the total amount of the variance explained by the factor. The larger this value, the more variance is explained by the factor. Following the Kaiser-Guttman criterion, five factors were extracted explaining 66 % of the variance. Prior to any preliminary interpretation of the factorial structure, the purification process was performed. As stated previously, items with cross-loadings above the 0.25 threshold on more than one factor were removed from the measurement instrument. A conditional check was also performed with respect to the theoretical meaning attached to the withdrawal of these items. Accordingly, TIMETOT, LOGINS, PROFIC and VA were removed. Although their potential influence on learning is significant, these items are clearly attached to two different dimensions. Their psychometric properties with respect to the measurement of a unique dimension of learning is limited. Similarly, MINICASE, BONUS, FACULTY and COMMSTOR, with 3 cross-loadings, were also removed from the instrument for the same reasons. Despite some weak loadings for some items at this stage, the remaining items were saved and a second EFA was performed using an OBLIMIN rotation.

Results of the second EFA are presented in Table 5.2. Once again, only loadings above the 0.25 mark are presented in this table.

Table 5.2

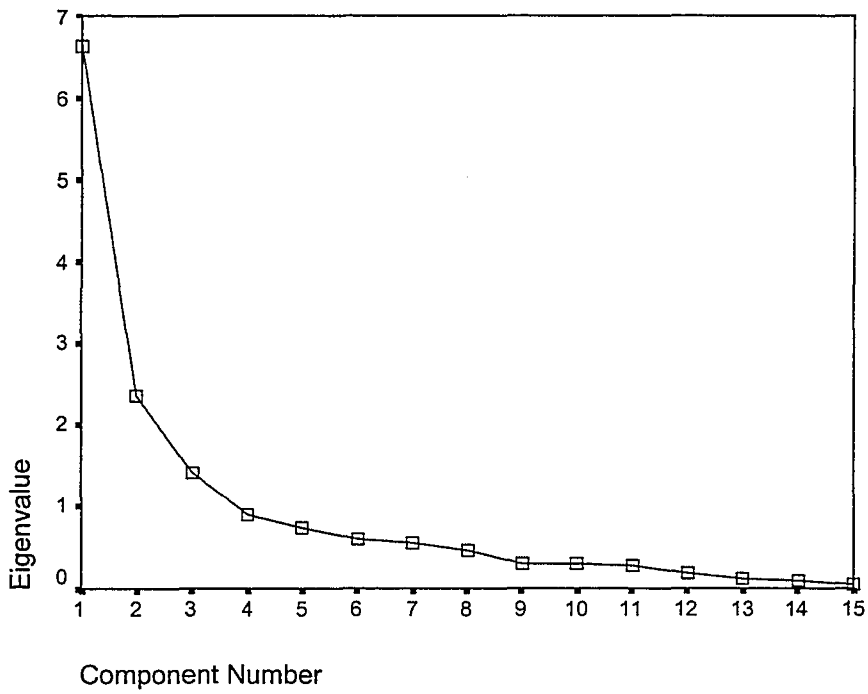
Exploratory Factor Analysis on the Purified Set of Variables.

	Principal Components		
	1	2	3
AXIOMS	.929		
NOTES	.921		
FACTS	.920		
VIDEO	.919		
CHAPTER	.912		
CRITIQUE		.742	
FEEDBACK		.713	
ARTICLE		.690	
MIDTERM		.644	
FINALEXA		.618	
ASSIGN		.614	
PRENU			-.874
PRESCORE			-.861
POSTSCORE			-.786
POSTNUM			-.774

Extraction Method: Principal Component
Rotation Method: Oblimin with Kaiser

Following the Kaiser-Guttman criterion, three factors were extracted with eigenvalues of 6.62, 2.36 and 1.40 respectively, explaining 69% of the variance. Using the Scree plot decision rule, the three-factor solution was also supported (see Figure 5.2).

Figure 5.2
Scree Plot for the Purified Set of Items



All the items in the three-factor solution have loadings above or close to the 0.7 threshold, and none of them has significant cross-loadings. Therefore, the purification process was not pursued after the first iteration. In addition, a scrutiny of the reliability results for each dimension shows very satisfying results following Nunnally's (1967) criterion with Cronbach alphas all above the 0.7 threshold. In fact, dimensions 1, 2 and 3 have Cronbach alphas of 0.94, 0.80 and 0.87 respectively.

The Refined Measurement Instrument

The final instrument in the confirmatory factor analysis used to measure learning includes fifteen items categorized under three dimensions. The first dimension contains five items and is described as a measure of knowledge acquisition. The second dimension has six items and represents mainly assessment components. The third dimension has four items and constitutes a measure of the practice effect. Each dimension presents strong internal consistency. The literature review supports these components as contributors to the definition of the learning concept. Therefore, this instrument will be used in the confirmatory step to test for the dimensionality as well as the validity of the concept of learning as defined by these three dimensions. The final set of variables is presented in Table 5.3.

Table 5.3

Description of Variables used in the Final Instrument

Factor / Variable	N	Description
Knowledge Acquisition		
1. Chapter	339	Total number of chapters read
2. Notes	339	Total number of times personalized notes were made
3. Video	339	Total number of times videos were watched
4. Axioms	339	Total number of times *Axioms* were read
5. Facts	339	Total number of times *Facts* were read
Assessment Components		
6. Article	312	Grade assigned for finding an article on the internet
7. Feedback	328	Grade assigned for peer feedback done in groups
8. Critique	339	Grade assigned for critique done in groups
9. Assignment	339	Grade assigned for term assignment posted online
10. Midterm	339	Grade assigned for term test posted online
11. Finalexa	339	Grade assigned for final exam written in person
Practice Effect		
12. PreNum	339	Number of online pre-tests attempted
13. PostNum	339	Number of online post-tests attempted
14. Prescor	326	Average score on online pre-tests
15. Postscor	326	Average score on online post-tests

An Integrated Model of Learning

Measurement and Structural Models

In this study, a Web-based model was conceptualized using three constructs with the expectation that the items initially selected for this study (Chapter 4) would fall along these constructs. As demonstrated in the previous sections, EFA was used to refine these items on the basis of their psychometric properties. The model is then tested using structural equation modeling (SEM) which is a tool employed for confirmatory analysis.

SEM is a comprehensive statistical approach to testing hypotheses about relationships among observed and latent variables (Hoyle, 1995). Exploratory analyses such as EFA are not used to specify an a priori model, even if the rules of extraction can be assimilated into a pattern of analysis. On the contrary, SEM and confirmatory analyses always begin with model specification, where the researcher specifies the model to be tested (Long, 1983). Model specification involves formulating a statement about a set of constants that indicate the nature of the relationships between variables referred to as parameters (Maruyama, 1998). Subsequently, the model fit is estimated and conclusions are drawn regarding the hypotheses.

The pattern of parameters in the model specification step defines the full (general) model. This model can have two components. First, the *measurement* model is that component of the general model in which latent variables are prescribed. Confirmatory Factor Analyses only consider the measurement model component. Second, the *structural* model is that component of the general model that prescribes relations between latent and observed variables that are not indicators of these latent variables (Hoyle, 1995; Kelloway, 1998). This structural part can be compared with a multiple regression that allows for latent variables and multiple outcomes. The SEM allows for the testing of both the measurement and structural parts simultaneously. The resulting model is a comprehensive or integrated statistical model that can be used to evaluate the relations among variables that are free of measurement errors.

In this study, the proposed conceptualization of learning involves both latent dimensions extracted from the EFA for the measurement part of the model as well as the influence of observed variables on the learning concept for the structural part of the model. Examination of both the measurement and structural part is supported by the literature review.

Structural equation modeling requires high levels of computation and statistical treatments using specific software. The first such software developed by Jöreskog and Sörbom (1989) is LISREL. Other more flexible and user-friendly software is commonly used by researchers with the same results. EQS software (Bentler, 1989) was selected for this study mainly because it uses easier syntax for programming and has the ability to represent schematic components of a model as path diagrams providing a visual portrayal of relations that are assumed to hold among the variables under study.

Specification and Overall Estimation

The *measurement* model expresses the relationship between indicators and the constructs as structural relationships, such as the following typical structural equation based on EQS notation (Bentler, 1989):

$$V2 = +{*}F1 + E2$$

Where V2 represents variable 2; F1 represents factor 1; * represents the parameter to be estimated (in other words, the loading of factor 1 on variable 2) and E2 represents the error term associated with variable 2.

Each variable and factor is defined by its own number and appropriate labels are presented in Table 5.4. The measurement model specifies the posited relations of the observed variables with the underlying constructs. The constructs are allowed to inter-correlate freely (Anderson and Gerbing, 1988). In addition to the first order structure specified above for each factor, a second-order factorial model is specified to conceptualize the construct for learning. Second order factor models often constitute an appropriate manner of shaping measurement models (Schumacker and Lomax, 1996) depicting relationships with the first order factors. As mentioned earlier, three factors were hypothesized, including knowledge acquisition (F1), practice effect (F2), and an assessment component (F3).

The hypothesis being tested was that the correlation between the first order factors

(F1, F2, F3) is attributed to a higher-order common structure (Roy, 1997). This second order factor is learning, specified as F5. The typical EQS notation for this specification is:

F1 = *F5 + D1

Where F1 is factor 1; * is the loading of factor 5 on factor 1 to be estimated and D1 is the disturbance term associated with the factor 1.

The *structural* model represents the specification of the theory-driven relationships between indicators and factors and amongst factors. Relationships are specified in EQS notation as:

F5 = *V16 + *V17 + *V23 + *V22+ D5

Where V16, V17, V23 and V24 are observed variables; * represents their respective loading on factor F5 (learning) to be estimated and D5 is the disturbance term associated with factor F5.

Each component of the integrated model (measurement and structural) is specified in the same program and estimated simultaneously. Therefore, the full model is estimated and conclusions are drawn about the fit of the integrated model. Several other specifications are noteworthy and are included in the tested version of the integrated model. For example, the researcher is free to select the fitting function to be used in the analysis. The most popular one is Maximum Likelihood (ML). ML is a normal theory based estimator that is very sensitive to any departure from normality. It is widely used in controlling for multivariate normality in the sample (Bollen, 1989) and was accordingly used in this study.

It should be noted that the loading of one indicator for each factor is fixed to the value of 1 in order to resolve scale indeterminacy, such that the scale of each factor is set equal to that of the selected observed variable (Roy, 1997; Schumacker and Lomax, 1996). Finally, before executing the EQS program, identification checks have to be performed. This includes the determination of whether the model is over or under identified. A structural equation model must always be overidentified, since underidentified models yield an infinite number of solutions and are thus indeterminate

(Schumacker and Lomax, 1996). To avoid any identification problems, one must ensure that the model has more data points than parameters to estimate (Byrne, 1994). Once all these steps have been performed, the specification is complete and the model can be estimated. The model specification used for this study is presented in Table 5.4. The model can also be presented pictorially. The measurement (first and second order models) and structural parts of the model are represented in Figure 5.3, 5.4 and 5.5 respectively. The integrated model is presented in Figure 5.6.

Table 5.4

Structural Program Specification

```
DATA='U:\FINANCE\DATA.ESS';
VARIABLES= 23; CASES= 338;
METHODS=ML;
MATRIX=RAW;
/LABELS
V1=NOTES; V2=VIDEO; V3=CHAPTER; V4=AXIOMS; V5=FACTS;
V6=PRESCORE; V7=POSTSCOR; V8=PRENUM; V9=POSTNUM; V10=CRITIQUE;
V11=FEEDBACK; V12=ARTICLE; V13=MIDTERM; V14=ASSIGN; V15=FINALEXA;
V16=TIMETOT; V17=LOGINS; V18=COMMSTOR; V19=MINICASE; V20=VA;
V21=BONUS; V22=FACULTY; V23=PROFIC;
/EQUATIONS
V1 = + 1F1 + E1;
V2 = + *F1 + E2;
V3 = + *F1 + E3;
V4 = + *F1 + E4;
V5 = + *F1 + E5;
V6 = + 1F2 + E6;
V7 = + *F2 + E7;
V8 = + *F2 + E8;
V9 = + *F2 + E9;
V10 = + 1F3 + E10;
V11 = + *F3 + E11;
V12 = + *F3 + E12;
V13 = + *F3 + E13;
V14 = + *F3 + E14;
V15 = + *F3 + E15;
F1 = *F5 + D1;
F2 = *F5 + D2;
F3 = 1F5 + D3;
F5 = *V16 + *V17 + *V23 + *V22+ D5 ;
/VARIANCES
D1 To D3 = *;
E1 To E15= *;
/COVARIANCES
E5,E4 =*;
E8,E6=*;
E11,E10=*;
```

Figure 5.3

The Measurement Model (First Order)

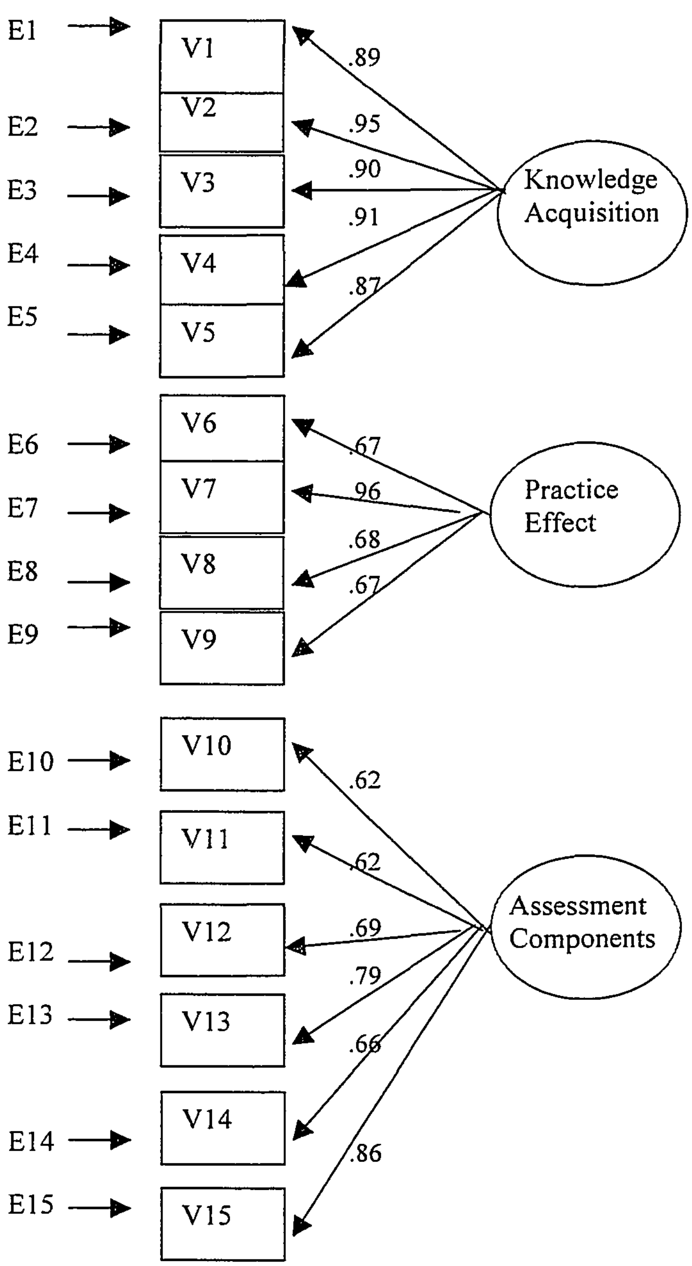


Figure 5.4

The Measurement Model (Second Order)

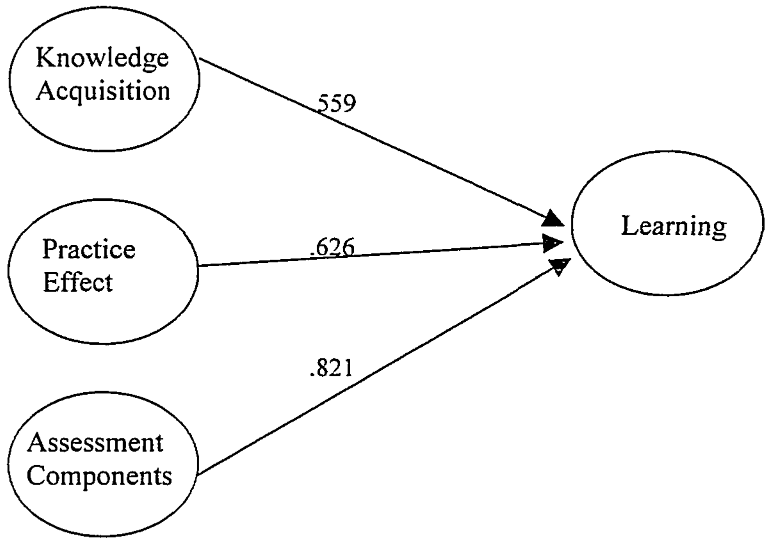
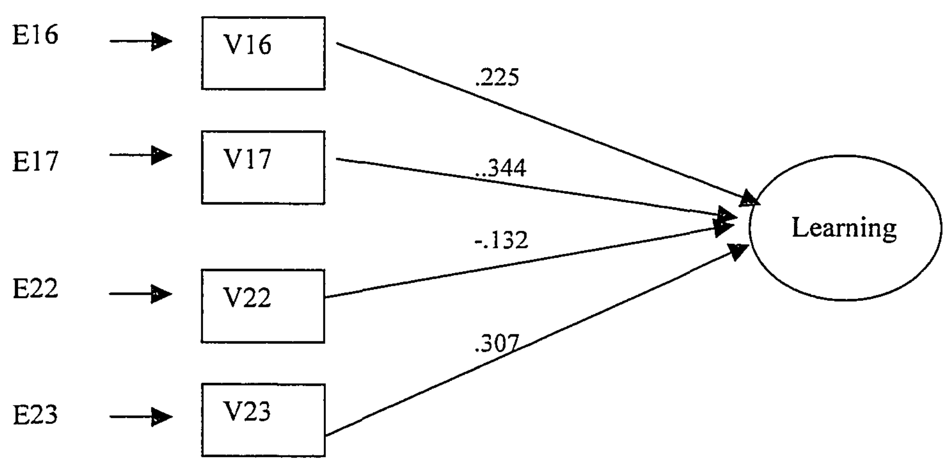


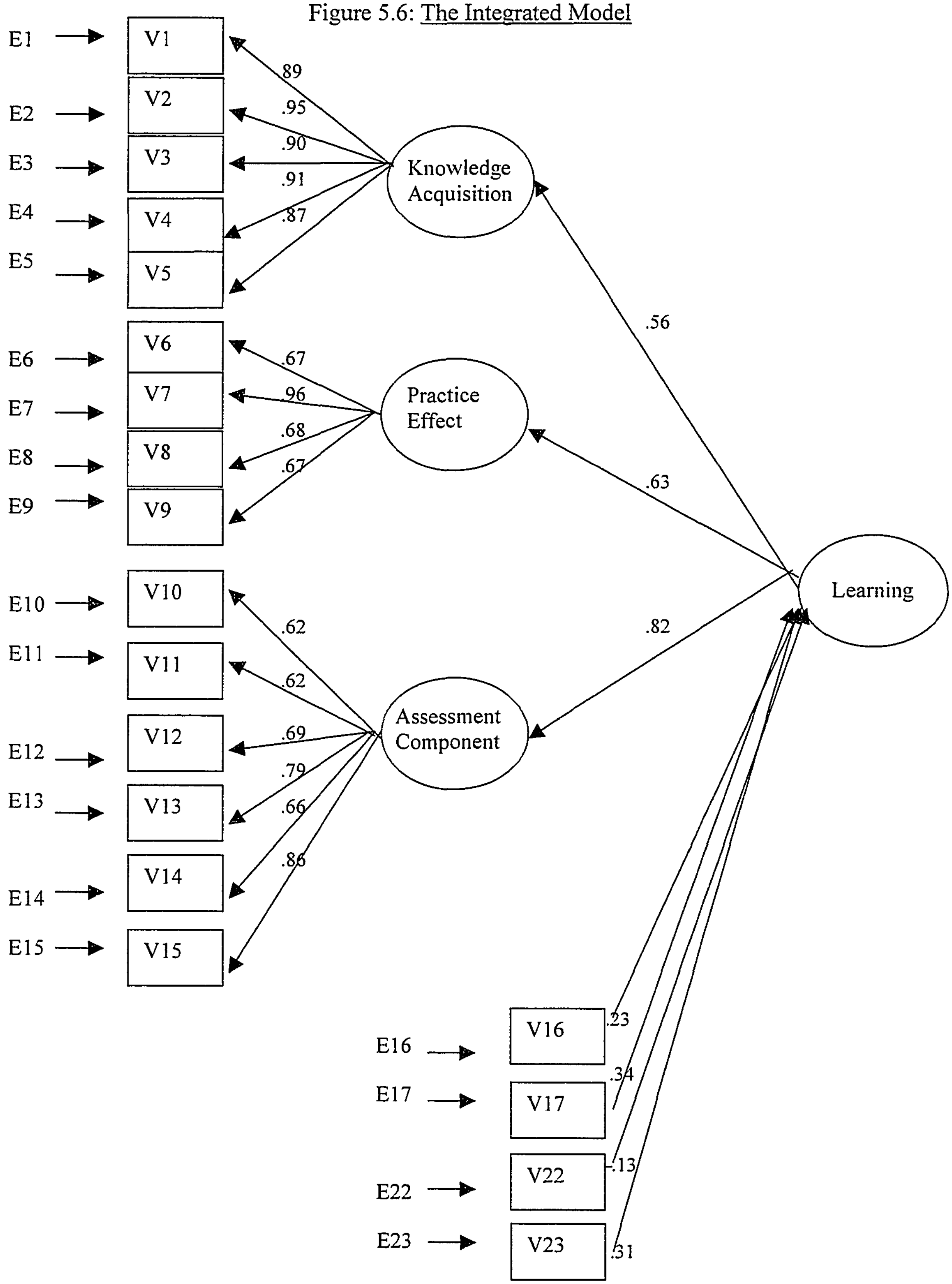
Figure 5.5

The Structural Model



Note: V16 = Time Logged Online; V17 = Number of times Logged
V22 = Faculty of Origin; V23 = Proficiency with technology

Figure 5.6: The Integrated Model



Overall Model Estimation and Fit Assessment

Byrne (1994) has suggested that models of average complexity should converge with a limited number of iterations (under 30). The integrated learning model converged after only eighteen iterations, thereby indicating that in general the specified model and the initial start values were adequate (see Table 5.5).

Table 5.5

Model Convergence - Iterative Summary

ITERATION	PARAMETER ABS CHANGE	ALPHA	FUNCTION
1	98.379906	0.50000	23.45942
2	58.716587	1.00000	11.01572
3	16.057735	1.00000	7.99117
4	10.152291	1.00000	5.78627
5	3.664379	1.00000	5.65876
6	0.648750	1.00000	4.39662
7	1.039649	0.50000	3.45117
8	0.412601	1.00000	2.39818
9	0.496202	1.00000	1.94404
10	0.833292	1.00000	1.67730
11	0.185403	1.00000	1.66589
12	0.119736	1.00000	1.66492
13	0.130330	0.50000	1.65937
14	0.002473	1.00000	1.65934
15	0.002049	1.00000	1.65934
16	0.001466	1.00000	1.65934
17	0.001673	0.50000	1.65934
18	0.000021	1.00000	1.65934

Hoyle (1995) suggests that the residuals should have the smallest possible value (under 0.1). In addition, these should be normally distributed around 0 (Byrne, 1994). In this study, the average off-diagonal absolute standardized residuals value is 0.091 and 70 % of the residuals are between –0.1 and + 0.1. (see output in Appendix J). These results satisfy Byrne and Hoyles's criteria.

Different indicators can be used to assess the overall fit qualities of the model. The χ^2 value has historically been the initial estimator of a model's fit (Bollen, 1989; Browne, 1989). However, its sensitivity to sample size and distributions has oriented researchers towards modified versions of the χ^2 (Anderson and Gerbing, 1988; Tanaka, 1993). The standardized χ^2 (χ^2 / degree of freedom) represents one alternative. The acceptance criterion ranges between 5 and 6 for the least stringent methods (Wheaton, Muthèn, Alwin, and Summers, 1977) and between 3 and 4 for the strictest approaches (Carmines and Mac Iver, 1981). Another fit indicator, the Comparative Fit Index (CFI), shows the relative improvement of the hypothesized model over a null model while taking into account relatively small size samples (Bentler, 1989). The cutoff value suggested for adequate fit is 0.90 (Bentler and Bonett, 1980).

The integrated (second order) learning model presented in Figure 5.6 satisfies fit properties regarding each of the previous alternatives to the χ^2. Given that the standardized χ^2 is 3.80 and the Comparative Fit Index is 90.6, we can conclude that the model fits reasonably well with the data and supports the factorial pattern underlying the learning model (see model output in Appendix J). Although the overall fit qualities of the model have been demonstrated, a scrutiny of each of the component's (measurement and structural) is still necessary to better understand the implications of how this model has conceptualized learning.

Measurement Model: Results and Discussion

Factor pattern

The factor pattern will be examined first as some results are useful for assessing the reliability and validity of the measurement instrument. This assessment enables the investigation of the relationship between constructs "without the bias that measurement error introduces" (Steenkamp and van Tripp, 1991; Roy, 1997). The standardized factor loading estimates as well as the z-statistic for each parameter are given in Table 5.6. With an alpha level of .05, the z-statistic has to be above the 1.96 threshold in order to be significant.

Table 5.6

Factor Loading Estimates and their Significance

ITEM	LOADING ESTIMATE	Z-STATISTIC	RELATED FACTOR
NOTES (V1)	.895	N.A	F1
VIDEO (V2)	.953	29.5	F1
CHAPTER (V3)	.904	25.8	F1
AXIOMS (V4)	.907	26.1	F1
FACTS (V5)	.868	23.4	F1
PRESCORE (V6)	.673	N.A	F2
POSTSCOR (V7)	.959	16.2	F2
PRENUM (V8)	.684	11.8	F2
POSTNUM (V9)	.671	10.1	F2
CRITIQUE (V10)	.616	N.A	F3
FEEDBACK (V11)	.617	7.8	F3
ARTICLE (V12)	.678	6.5	F3
MIDTERM (V13)	.787	7.7	F3
ASSIGN (V14)	.655	8.2	F3
FINALEXA (V15)	.861	9.3	F3

The second order factor pattern is also estimated by the same method. All three factor-loadings on F5 of F1, F2 and F3 are significant at the .05 level. Their standardized estimates are .559, .626 and .821 respectively, suggesting that the strongest relative contribution to the measurement of learning is made by F3 (Assesment Components). Given the previous results, the hypothesized factor pattern is confirmed through confirmatory factor analysis. However, in order to fully evaluate the measurement instrument, validity and reliability estimates are presented below.

Assessment of Validity and Reliability

The validity of a scale is concerned with the absence of bias (or non-random error in the scale). However, it is multifaceted in that there are different kinds of validity (Davis and Cosenza, 1993) and as mentioned by Kerlinger (1986), "the subject of validity is complex, controversial, and peculiarly important in behavioral research" (p. 456). While there are many different forms of validity that attempt to address the overall question of "whether we are measuring what we think we are measuring", three types of validity have been classified by the American Psychological Association and the American Educational Research Association. These are (a) content validity, (b) construct validity, and (c) criterion-related validity.

Content validity is concerned with the ability of indicators to fully encompass the domain of the concept. Since "fully encompass" is a qualitative concept, content validity is reflected in sampling adequacy, representativeness, and good judgement. (Carmines and Zeller, 1980). Given the thorough exploration of the domain in the literature review, this form of validity has been assessed qualitatively. Although the variables selected provide a limited set of indicators in capturing the factorial structure of the learning model, considering their strong theoretical support, it is felt that the model achieves a high degree of content validity.

Construct validity is the extent to which a construct achieves empirical and theoretical meaning (Steenkamp and van Tripp, 1991) and represents the most significant advances of modern measurement theory and practice. Lord and Novick (1968) suggest that "for scientific purposes, the most important characteristic of a test is its construct validity", because it unites psychometric notions with theoretical notions. In addition, reliability is a prerequisite to the assessment of construct validity (Ahire, Golhar, and Waller, 1996), that is made operational through the assessment of convergent and discriminant validity.

The reliability of a scale is the degree to which it is free from random error, such that a "measuring procedure yields the same results on repeated trials (Carmines and Zeller, 1980). Reliability can be assessed in many different ways. For practical reasons, only internal consistency through Cronbach's alpha was computed for each dimension of the scale and the instrument as a whole. These results are presented in Table 5.7. The overall instrument reliability is 0.79 for all fifteen items. These results satisfy Nunnallys (1967) criterion of a 0.7 value.

In this study, the approach used to assess convergent and discriminant validity relies on the methodology presented by Fornell and Larcker (1981) and effectively used by other researchers (Netemeyer, Durvasala, and Lichtenstein, 1991). It is based on the assumption that the convergent validity of the model is demonstrated if the average variance extracted (representing the square of the parameter estimates) between a construct and its measures is above the 0.50 threshold. This statement is similar to the test for variance due to measurement errors, which must be inferior to the variance captured by the construct.

On the other hand, discriminant validity is demonstrated when the variance shared between two constructs measuring the same general concept is inferior to the average variance extracted between a construct and its measures (Fornell and Larcker, 1981). A first order CFA model is then respecified for the discriminant analysis in order to obtain the covariances between first order factcrs and to compare them with the average variance extracted that is calculated for each factor in the convergent validity check. The results are presented in Table 5.7.

Table 5.7

Convergent and Discriminant Validity Tests

Convergent Validity	Average Loading	Average Variance Extracted	Reliability
Knowledge Acquisition	0.90	0.81	0.94
Practice effect	0.79	0.62	0.80
Assessment components	0.71	0.51	0.87

Discriminant Validity	Variance between Constructs
Knowledge Acquistion and Practice Effect	0.32
Knowledge Acquisition and Assessment Components	0.49
Practice Effect and Assessment Components	0.48

All values for convergent and discriminant validity satisfy Fornell and Larcker's (1981) criterion. It should be noted, however, that the convergent and discriminant validity for the Assessment Components dimension as well as the discriminant validity for the Practice Effect dimension are close to the criterion's limit. Therefore, even if the construct validity of the instrument is confirmed, these two dimensions and their measurement might be problematic and would probably need new validity assessment in subsequent research.

Criterion validity is concerned with the extent of the correspondence between the scale and an external variable, the criterion (Carmines and Zeller, 1980). This is a predictive facet of validity, which can be partly confirmed by assessing a validity coefficient computed as the absolute value of the correlation between the test and a specified criterion (Kerlinger, 1986; Lord and Novick, 1968). Stated differently, Vogt (1993) defined criterion related validity as the ability to make accurate predictions regarding the reciprocal influence between the test and the criterion. To assess this type of validity, theoretical connections between learning and other concepts have to be hypothesized and the measurement of this criterion has to be included in the experiment. Given the Web-based context of the course, and the absence of external criterion in the measurement tool in this study, this type of validity was not assessed.

In conclusion, it is important to emphasize that almost no study can fully assess all types of validity. With respect to the results pertaining to the assessment of both construct and content validity above, there seems to be strong support for the hypothesized second order conceptualization of learning in the context of Web-based instruction.

The Structural Model

The structural component of the model hypothesizes four external variables that influence learning as captured by the three first order factors. The standardized structural parameters are all statistically significant at the .05 level and are summarized in the following equation:

F5 (Learning) = **.225***V16 (Time logged on) + **.344***V17 (Number of times logged) – **.132***V22 (Faculty of origin) + **.307***V23 (Proficiency with technology).

It is important to recognize that these coefficients are interpreted as regression coefficients. The longer the learner stays logged on, the more frequently he logs on and the more proficient he is with the technology, the more he will learn. The coding for Faculty suggests that learners with non-business backgrounds tend to perform lower on the overall grade than those from the business faculty.

The R^2 for the variance explained for learning by these external variables is about .281. This suggests the importance of these variables in defining learning. It is considered significant considering the multitude of effects that can possibly explain the complex construct of learning. Thus, this result does not preclude the possible addition of other variables in order to improve the variance explained. While this study was constrained in tracking other online data that might have revealed more variables, additional surveys were designed and implemented to provide information on other important aspects of student learning. These are discussed in the following section.

Analysis of Survey Instruments

Four surveys were administered to participants enrolled in the *Personal Finance* course during the fall semester of 1999. These include two identical paper-based surveys during the start and end of the semester (see Survey I and II in Appendices C and D), an online survey during the middle of the semester (see Survey III in Appendix E) and an end-of-term online survey (see Survey IV in Appendix F). Highlights of the findings from this survey data is presented below.

Learner Profile

A total of 290 and 307 participants respectively responded to Surveys I and III. Participants' ages ranged between 17 to 54 years old. The average age was 21 years. Sixty percent were male and this ratio remained unchanged for the balance of the semester. With respect to environments that best suit their learning style, the majority (75 percent) indicated a preference for a mixture of discovery learning and guided instruction, with the remainder evenly split between the two. This distribution did not change at the end of the course.

While most participants (56 percent) anticipated spending up to three hours per week on the course followed by 39 percent who thought they would spend up to six hours per week, by the end of the semester, these percentages had been reversed. At the end of the term, more than half of the participants (58 percent) reported to have spent between three and six hours per week on the course while 30 percent reported to have spent up to 3 hours. Most of this time was spent online, with reported increases considering participant expectations and their actual experience. In a separate online survey during the middle of the semester ($n = 242$) the same trend of time spent online was reported (Table 5.8).

Table 5.8

Time Spent Using Online Tools

Hours	Percentage
0 – 5	49
5 – 10	12
10 – 25	20
25 plus	15
Don't Know	4
Mean	11 hours

We can speculate that time spent on learning activities is partly related to the level of prior knowledge. At the start of the course, approximately 19 percent of the participants had indicated their prior knowledge on various course related issues to be High or Very high. By the end of the course, students responded to their present knowledge on the same dimensions and to have increased to about 49 percent. (see Table 5.9).

Table 5.9

Knowledge on Issues in Personal Financial Management

	Prior sample		Post sample	
	N	%	N	%
Low	88	30	21	7
Medium	147	51	136	44
High	44	15	127	41
Very high	10	3	23	8
Missing	1	.3		
Total	290	100	307	100

Prior knowledge was further explored in Section III of the Survey as it relates to six specific learning goals of the course (see Question 14 in Surveys I or III). Results indicate the following changes in the percentage of participants responding to High and Very High categories (collected from the Pre and Post semester surveys); (a) declarative knowledge increased from 27 percent to 73 percent, (b) the ability to articulate issues increased from 32 percent to 76 percent, (c) the ability to critique popular publications increased from 21 percent to 52 percent, (d) the ability to critique views expressed in the media increased from 26 percent to 63 percent, (e) the ability to identify priorities in personal financial plans increased from 40 percent to 83 percent, and (f) the ability to make financial decisions increased from 39 percent to 77 percent.

Proficiency with Technology

Several recent studies in the computer-mediated-communication literature emphasize the importance of the learner's access to and proficiency with various emerging technologies (Higgins, 1998; Paulsen, 1995; Shih and Gamoon, 1999). Also, there are different ways to access the web. According to Becker (1999), the type of pathway that students take will determine the level of usage of the Internet. Furthermore, high speed, ease of use and connectivity are among the important factors that influence the level of use of the web.

Table 5.10 shows that the majority of participants have access to the web through an Internet provider and over two-thirds are connected via dialup where the speed of connection is noticeably faster with the former. Also, it can be assumed that many have access both ways. This is not surprising, since having access to the Internet was indicated as a pre-requisite to the course.

Table 5.10

Type of Access to the Web

	Internet provider	Dialup
No	6%	24%
Yes	93	68
No answer	1	8

Although 90 percent of the participants had never taken a web-based course, the majority indicated a high level of familiarity with respect to the computer, the Internet, and on-line tools. As shown in Table 5.11, towards the end of the course, changes in the percentage of participants responding to the High and Very High categories was greatest with the Internet (from 66% to 83%). Relatively high percentage increases were reported for computer use as well as the Internet.

Table 5.11

Familiarity with using a Computer, the Internet and Email

	Computer		Internet		Email	
	Prior	Post	Prior	Post	Prior	Post
Low	3%	1%	4%	2%	5%	2%
Medium	24	15	29	14	20	14
High	35	35	30	33	32	30
Very High	37	49	36	50	41	53
Missing	1	0	2	2	2	2
Total (%)	100	100	100	100	100	100

Note: Due to rounding the numbers may not add up to 100%.

During the middle of the semester, Survey II was administered online to better understand the various aspects of technological proficiency amongst participants and to generate information for determining effective intervention solutions to improve the course.

Table 5.12

Working with the Computer and Basic Software

	Computer	Word Processing	Spreadsheet or Database
Low	3%	0%	11%
Medium	27	21	31
High	69	78	57
No answer	0	1	1

In general, almost all of the participants claim to have a medium to high level of skill in working with the computer and basic word-processing programs (see Table 5.12). While 11% indicated low skill levels with spreadsheets or database programs, these skills are not considered important for this course. However, other skills have been emphasized. For example, students were encouraged to take advantage of websites suggested to further their understanding of a particular topic. As well, assignments required students to do research on the Internet to find articles and gather information for their group critique. From Table 5.13 it appears that students are comfortable in performing simple searches, download files, etc. Thus, basic information on the learner's proficiency with technology confirmed that tasks which assumed these skills were appropriate.

Table 5.13

Working on the Internet

	Searching for info	Downloading files or software	Using descriptors or Boolean commands
Low	6%	34%	13%
Medium	28	31	30
High	66	34	56
No answer	0	1	1

In addition to research skills on the Internet, communication skills are an integral part of assigned tasks in *Personal Finance.* Participants are required to keep in touch with group members, post and respond to work-in-progress, seek technical support and take advantage of various features inherent in FirstClass™ such as e-mail, edit, attach, chat, etc. According to Table 5.14, students classified their overall skills in using the prescribed software (FirstClass™) as evenly distributed between Low, Medium, and High categories, even though their familiarity with specific features varied. It should also be noted that while 71 percent reported low level skills with respect to Listserves, these are not a requirement for the course.

Table 5.14

Working with Communication Software

	Participating in a Listserve	Using FirstClass	Using E-Mail	Sending and Receiving Files	Chat Feature
Low	71%	35%	4%	10%	22%
Medium	3	34	13	23	27
High	23	31	82	65	50
No	3	0	1	2	1

The summative question on overall proficiency is consistent with the data reported above. Over half of the participants rated their overall proficiency as High (55 percent), over one-third rated it as Medium (37 percent) and the remainder rated it as low. As discussed in the first part of this chapter, proficiency with technology was hypothesized to influence the learning model. Results indicated that this variable (PROFIC) is statistically significant at the .05 level as a structural parameter that partially explains the overall construct of learning.

Motivational Factors

The following indicators were used to provide information on motivational factors that may have influenced participants in selecting *Personal Finance*: (a) enthusiasm for the course, (b) degree of difficulty when compared to other elective courses, (c) the perceived value of the course, (d) the level of effort invested, (e) grades expected and, (f) the importance of access and convenience. (see section II of Surveys I and II for specific questions in Appendix C and D).

Results indicate the following changes from the beginning (Pre) until the end of the semester (Post) in terms of the percentage of participants responding to each of the indicators mentioned above (see Table 5.15).

Table 5.15

Factors Influencing Course Selection

Scale	Enthusiasm		Degree of Difficulty		Value of Topics		Level of Effort		Easy Grade		Access and Convenience	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Very High	28%	23%	5%	10%	37%	42%	9%	13%	40%	18%	33%	28%
High	56	38	30	35	45	43	37	61	49	46	45	43
Medium	16	31	61	48	16	14	46	22	10	34	17	20
Low	0	8	3	6	1	1	8	3	0	2	3	7
Missing	0	0	2	0	2	0	0	0	1	0	2	1

Note: Due to rounding, the totals may not add up to 100 percent

For High and Very High categories, the level of enthusiasm decreased from 84 to 61 percent, with the difference accounted for in the Medium category. The degree of difficulty increased from 35 to 45 percent. This positively correlates with the anticipated effort (prior to taking the course) versus the actual effort invested in the course increasing from 47 to 74 percent. On the other hand, given the perception that the course was more difficult than expected, grade expectations decreased from 89 to 64 percent. This finding has been noted by others in terms of unrealistic student perceptions regarding time-on-task activities for online courses and the consequent high rates of attrition that follow (Margolis, 2000; Sherry, 1998; Treadwell, Leach, Kellar, Lewis, and Mittan, 1998). Finally, the value of topics rated High or Very High remained fairly constant during the semester (above 80 percent), as did the importance of taking the course based on access and convenience (above 70 percent).

While questions regarding these indicators provide some insights, participants also rated the relative importance of these indicators in terms of their selection of *Personal Finance.* These are summarized in Table 5.16.

Table 5.16

Relative Importance of Factors Influencing Course Selection

Note: Scale 1 = Most Important; 2 = Next most important ... 6 = Least Important

Scale		Enthusiasm		Degree of Difficulty		Value of Topics		Level of Effort		Easy Grade		Access and Convenience	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	N	66	61	23	12	122	108	27	22	33	27	88	111
		18%	18%	7%	4%	34%	32%	8%	6%	9%	8%	25%	33%
2	N	73	69	54	57	69	89	44	60	41	46	78	79
		20%	17%	15%	14%	19%	22%	12%	15%	11%	12%	22%	20%
3	N	72	70	35	39	33	25	43	59	19	37	47	44
		29%	26%	14%	14%	13%	9%	17%	22%	8%	14%	19%	16%
4	N	24	27	68	65	17	26	68	70	29	31	23	21
		10%	11%	30%	27%	7%	11%	30%	29%	13%	13%	10%	9%
5	N	17	31	53	67	24	30	63	64	35	33	15	17
		8%	13%	26%	28%	12%	12%	30%	26%	17%	14%	7%	7%
6	N	24	34	43	53	10	16	30	17	118	118	25	21
		10%	13%	17%	20%	4%	6%	12%	7%	47%	46%	10%	8%

The most important factor that influenced course selection is access and convenience, which is also the most cited reason in the literature why learners take online courses (Oblinger and Rush, 1997; Owston, 1997; Sherry, 1998). This is closely followed by the importance attached to the value of the topics. Enthusiasm was rated the third-most important factor. The degree of difficulty, the level of effort, and grade expectations were not considered to be as important.

Tool Use

Course tools were categorized as (a) print materials, (b) videos, (c) online information, (d) communication software, and (e) online interactive practice tests. At the start of the semester, course tools that were perceived as most enjoyable were fairly evenly distributed amongst the five categories above with online information and videos ranking the highest and print material the lowest. However, at the end of the semester, at least one third of all participants ranked online interactive practice tests as the most enjoyable tool with preferences for the remaining tools distributed evenly. On the other hand, the percentage of those participants who at the start of the semester thought print material would be the least enjoyable tool decreased from 46 to 27 percent by the end of the semester.

Online information, print material and communication software were perceived as the most frequently used tools participants would use. However, the post sample indicated print material, online interactive practice tests and online information as the most frequently used tools, accompanied by a sharp decline in the use of videos. Thus, in terms of frequency of use enjoyment, printed materials and online interactive practice tests ranked high in preference.

Questions on tool use were also linked to their role in helping participants accomplish assigned tasks in the course (see Table 5.17). Online Practice Tests were regarded as most helpful in preparing for tests (62 percent in the post course sample). Similarly, Online information was considered most helpful in critiquing an article closely followed by print materials. While all tools (except Online Practice Tests) played a part in enabling discussion comments, print material was regarded as the most helpful. Not surprisingly, Online Information (including websites for each topic) were regarded as most helpful in research assignments, although print materials were once again considered significant. These results are interesting in terms of participant perceptions about the importance of traditional print-based tools (a textbook and popular articles).

Table 5.17

Ranking of Tools Considered Most Helpful in Course Activities

Mediating Tools	Preparing for Tests		Critiquing Article		Discussion Comments		Research Assignments	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Print Material	31%	28%	33%	34%	34%	42%	12%	25%
Videos	5	4	21	7	14	12	5	4
Online Information	18	6	35	40	32	26	63	60
Communication Software	2	0	9	15	15	14	16	9
Online Practice Tests	44	62	2	4	5	6	4	2

The Summative Evaluation

The final survey - the Summative Evaluation, was implemented online during the last two weeks of the course. Questions were selected from validated instruments used at the University as well as from the Flashlight Program sponsored by the Teaching, Learning, and Technology affiliate of the American Association of Higher Education. In addition, considering the extensive literature on course evaluation design, seminal contributions by experts were reviewed for item generation and for grouping items in appropriate categories (Apollonia and Abrami, 1988; Cohen, 1990; Ehrmann, 1999; Greenwald, 1997; Marsh and Roche, 1977, Mckeachie, 1997). Four categories were created under the following headings: (a) The Web Site, (b) The Learning Tools, (c) The Instructor, and (d) The Course. Items were generated for each category followed by an overall question to that summarized each category (see Appendix F).

As can be seen in Table 5.18, the scores are on a Likert Scale ranging from 1 to 5, where 1 indicates that participants *strongly agree* with the item, 2 that they *agree*, 3 that they are *neutral*, 4 that they *disagree*, and 5 that they *strongly disagee*. Results are provided in Table 5.18 (percentiles, mean scores and standard deviations).

From Table 5.18, it can be seen that the mean score is generally around 2, which indicates positive agreement with the items in the survey. There are no negative mean scores (below neutral) for any of the questions and the standard deviations are relatively small. In addition, course evaluation literature reports a general tendency for smaller class sizes to receive higher ratings from the students (Mckeachie, 1997). Considering the large sample for *Personal Finance* (N ranges between 234 and 239 participants), the results are above average across the board. Highlights from each section are summarized on the following page in Table 5.18.

The mean score for questions 1 and 2 (website navigation and rich in content) was equally rated at 1.98 and is representative of positive ratings for the entire evaluation (see Figure 5.7).

Figure 5.7

Course Content

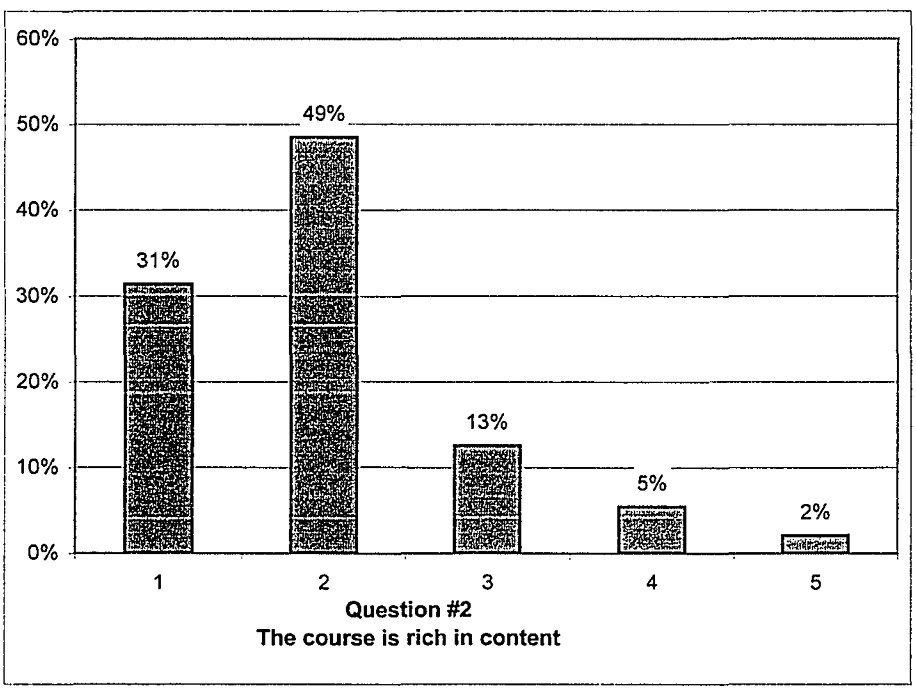


Table 5.18

Summative Evaluation Results

Q	Item	N	1	2	3	4	5	Mean	S.D.
	THE WEBSITE			Liu					
1	Is easy to navigate	238	0.30	0.53	0.08	0.07	0.02	**1.98**	0.21
2	Is rich in content	239	0.31	0.49	0.13	0.05	0.02	**1.98**	0.20
3	Provides many opportunities to learn	238	0.30	0.49	0.15	0.04	0.03	**2.00**	0.19
4	Accommodates the way I like/prefer to learn	236	0.19	0.41	0.25	0.11	0.05	**2.42**	0.14
5	Overall, it is well designed	237	0.24	0.50	0.16	0.07	0.03	**2.14**	0.19
	THE LEARNING TOOLS								
6	The textbook is a valuable learning resource	235	0.33	0.41	0.14	0.09	0.03	**2.07**	0.16
7	The Concordia videos are a valuable learning resource	237	0.08	0.41	0.32	0.11	0.08	**2.73**	0.15
8	The CBC videos are a valuable learning resource	235	0.09	0.45	0.29	0.10	0.07	**2.60**	0.16
9	The chapter websites are a valuable learning resource	236	0.11	0.44	0.33	0.07	0.04	**2.49**	0.18
10	The axioms are a valuable learning resource	237	0.07	0.49	0.29	0.11	0.04	**2.56**	0.16
11	FirstClass is a valuable learning resource	237	0.17	0.46	0.21	0.11	0.06	**2.43**	0.20
12	There are sufficient tools to promote interaction with Course material.	235	0.22	0.54	0.16	0.06	0.03	**2.15**	0.20
13	Overall, the tools helped me to learn about personal Finance	236	0.23	0.53	0.15	0.05	0.03	**2.13**	0.20
	THE INSTRUCTOR								
14	Makes the student feel welcome in seeking help	237	0.34	0.40	0.17	0.06	0.03	**2.04**	0.16
15	Provided useful information on a timely basis	236	0.29	0.49	0.14	0.06	0.03	**2.05**	0.15
16	Created an atmosphere of encouragement and support	236	0.25	0.42	0.22	0.08	0.04	**2.24**	0.15
17	Created an atmosphere to encourage student participation	236	0.22	0.44	0.24	0.08	0.02	**2.25**	0.16
18	Provided grades on a timely basis	237	0.08	0.32	0.28	0.18	0.14	**2.96**	0.10
19	Is accessible	235	0.26	0.44	0.20	0.08	0.03	**2.19**	0.16
20	Overall, the instructor performed effectively	236	0.25	0.51	0.16	0.06	0.03	**2.10**	0.19
	THE COURSE								
21	The course outline is clear and complete	236	0.26	0.50	0.12	0.07	0.05	**2.13**	0.19
22	The methods used for evaluating student work are fair	234	0.12	0.27	0.25	0.23	0.13	**2.99**	0.07
23	The subject matter of this course is something that I consider useful	235	0.49	0.39	0.09	0.01	0.03	**1.70**	0.22
24	There is sufficient help available to resolve technical Issues	237	0.18	0.47	0.22	0.08	0.05	**2.35**	0.17
25	Overall, I have learned a great deal in this course	236	0.26	0.52	0.14	0.04	0.03	**2.07**	0.20

The overall question for the first category (Website), "it is well designed" also received a very good rating (2.14) with approximately 75 percent of the participants indicating agreement or strong agreement with this statement. For the second category of items (Learning Tools), the textbook was ranked more favourably (2.07) than any other tool. The lowest rating was for the short videos (2.73), although given the 5-point scale, this score is still above average. Other key questions in this section concerned interaction (item #12), and the overall question of whether tools enabled participants to learn (item #13). The mean scores for these questions were 2.15 and 2.13 respectively.

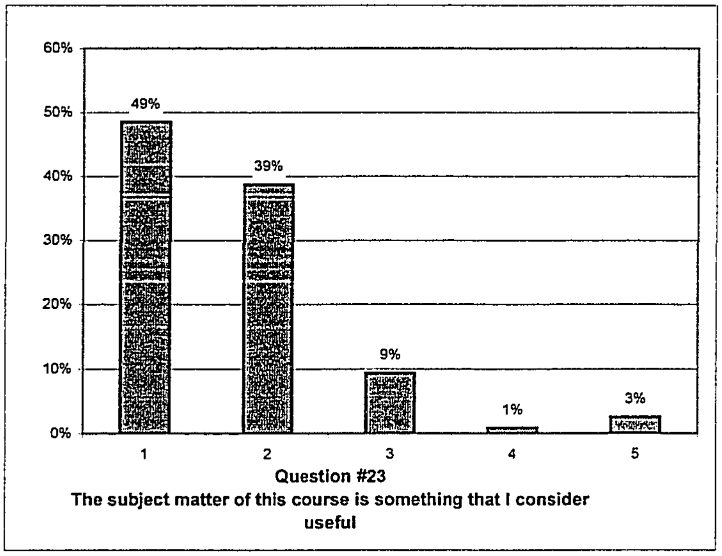
The mean score for all items under the Instructor category was favourable, except in the case of the question providing grades on a timely basis (item #18). The mean score for this question is 2.96, with a fairly even distribution around the mean. The logistics of one instructor managing a large class of 338 participants with minimal grading assistants may have contributed to delayed feedback. However, despite the average turnaround of ten days feedback on any given assignment, the technology-intensive nature of the course may have raised higher participant expectations about feedback.

A similar concern was reflected in responses to item 22, "methods used to evaluate student work", which had a mean score of 2.99. As described in Chapter 3, a number of different assessment methods were used to accommodate diverse learning styles and preferences. While this approach is inclusive, it could also have alienated some participants who are accustomed to the traditional mid-term / final exam format. In addition, strict guidelines were applied in the assessment process.

On the other hand, Item 23, which asks about the usefulness of subject matter, received the most favorable rating in the entire evaluation (1.7). The applied nature of the topics as they relate to personal decision-making may explain why usefulness was rated positively (Figure 5.8).

Figure 5.8

Usefulness of Subject Matter



Summary

This chapter presents two types of results for a design experiment in a technology-rich Web-based course in *Personal Finance*. The first set of results relates to model specification and tests for its goodness of fit, while the second set presents findings from four surveys implemented during the semester. In the first part of the chapter, procedures that were used to develop and test a valid measurement instrument were introduced. This instrument was designed to capture a second-order latent factor labelled "learning." The underlying model specified three broad constructs that were used to identify variables that influence learning. These include (a) knowledge acquisition strategies, (b) cognitive tools that support practice opportunities, and (c) assessment components that capture artifacts of learning.

Online and offline data were gathered on the basis of providing indicators for the three constructs mentioned above. Using OBLIMIN rotation, exploratory factor analysis was conducted on twenty-seven variables. Following refinement procedures, the second iteration revealed three underlying factors consisting of fifteen variables. By applying strict statistical rules with respect to factor loadings, inter-item correlations, and minimum eigenvalues, the three extracted factors explain 69% of the total variance and loadings above or close to the 0.7 threshold.

Thus, the three dimensions of the learning model include (a) five items that measure knowledge acquisition, (b) four items that measure the practice effect, and (c) six items that represent assessment components. The literature review supports these items and constructs as contributors to the definition of the concept of learning.

Given these dimensions and the second-order latent construct (learning), Structural Equation Modelling techniques were applied to confirm the *measurement* model. In addition, a *structural* component of the model was specified to include four other observed variables that were hypothesized to influence learning. The inclusion of both the measurement and structural parts constituted an integrated model of learning.

EQS software was used to confirm the full model in terms of its goodness of fit characteristics and to determine loadings of its structural components. Prior to analysis and interpretation of results, identification checks were performed. This resulted in the determination that the integrated model is over-identified (a requirement), and satisfactory convergence of the model resulted after only eighteen iterations.

Various statistical results were highlighted from the output generated by EQS. For example, the average off-diagonal absolute standardized residuals value is 0.091 and 70 percent of the residuals are between –0.1 and + 0.1. These results satisfy Byrne (1994) and Hoyles's (1995) criteria. Furthermore, goodness of fit results were deemed to be extremely satisfactory. The standardized χ^2 is 3.80, and using Bentler's (1989) threshold, the Comparative Fit Index is 90.6. Furthermore, the three factor loadings on learning are significant at the .05 level. The standardized estimates for knowledge acquisition, the practice effect and assessment components are .56, .63, and .82 respectively. These results indicate that the strongest relative contribution to the measurement of learning is reflected in the artifacts produced by participants labeled as assessment components. The general conclusion for the measurement model is that it fits well with the data and supports the factorial pattern underlying the learning model.

This result necessitated the assessment of the reliability and validity of the measurement instrument. With respect to validity, three types were examined: (a) content validity, (b) construct validity, and (c) criterion-related validity. First, given the strong theoretical support of the indicators selected, it was felt that the model achieved a high degree of content validity. Second, construct validity was assessed by first determining the overall instrument reliability. This was done by using Cronbach's alpha for each dimension of the scale and for the instrument as a whole. The overall instrument reliability is 0.79 for all fifteen items satisfying Nunnally (1967) criterion of a 0.7 value. This was followed by assessing convergent and discriminant validity using the methodology presented by Fornell and Larcker (1981). All values for convergent and discriminant validity satisfy Fornell and Larcker's (1981) criterion. Finally, criterion-related validity was not assessed because of the difficult inclusion of external criterion in the measurement tool given the Web-based context of this course.

Having confirmed the measurement portion of the model and having performed validity and reliability checks on the measurement instrument, four structural components were included to test the overall learning model: (a) Time logged on, (b) Number of times logged, (c) Faculty of origin, and (d) Proficiency with technology. The interpretation of their relative regression coefficients suggests that the longer the learner stays logged on, the more they log on, and the more proficient they are with technology, the more they will learn. In addition, learners with business backgrounds tend to perform better in the course than those who come from other faculties. This section concluded with the observation that while the integrated model identifies several dimensions that explain learning, it does not discount the possibility of other variables that explain the multifaceted construct of learning.

The second part of the chapter revealed a number of findings from two off-line surveys ($\underline{n}$ = 290 and 307 participants) and two on-line surveys ($\underline{n}$ = 242 and 234 participants) administered throughout the semester. Selected highlights are mentioned below.

Sixty percent of the participants were male, with an average age of 21 years. The majority (75 percent) indicated a preference for a mixture of discovery learning and guided instructional environments that best suited their learning style. Generally, participants spent approximately six hours per week on the course. At the start of the course, participants indicated fairly low levels of prior knowledge on each of the five dimensions of learning goals for the course. These were (a) declarative knowledge, (b) the ability to articulate issues, (c) the ability to critique popular publications, (d) the ability to critique views expressed in the media, and (e) the ability to make personal financial decisions. Participants reported significant increases in all of these learning goals. For example, by grouping together the "High" or "Very High" categories, the ability of participants to make financial decisions increased from 39 to 77 percent.

In terms of proficiency with technology, 93 percent of participants have access to the web through an Internet provider while 68 percent report being connected via dialup. In general, almost all of the participants claim to have a medium to high level of skill in working with the computer and its basic word-processing programs, as well as high levels of familiarity with the Internet. Most had used email and were comfortable searching for information, downloading files, and using other features on the Web. With respect to communication skills, the majority of participants rated their overall proficiency as High, although in another survey they did not rank communication software very high on their preference for online tools.

The surveys were also used to provide information on motivational factors that may have influenced participants in selecting *Personal Finance*. These included (a) their enthusiasm for the course, (b) the degree of difficulty when compared with other elective courses, (c) the perceived value of the course, (d) the level of effort invested, (e) the grades expected, and (f) the importance of access and convenience. The most important factor that influenced course selection was access and convenience, closely followed by the importance attached to the value of the topics.

With respect to tool use, most participants indicated print material, online interactive practice tests, and online information as the most frequently used tools. There was a decline in the use of videos with the progression of the course. Tools that enabled participants to accomplish specific learning objectives were also rated. For example, online practice tests were regarded as most helpful in preparing for tests, whereas online information on the course Website was regarded as most helpful in critiquing articles and in research-based assignments.

The summative evaluation collected data on the following four categories: (a) The Web Site, (b) The Learning Tools, (c) The Instructor, and (d) The Course. Items were generated for each category followed by an overall question that summarized each category. Using a five-point Likert Scale ranging from strongly agree (1) to strongly disagree (5), the mean score for the majority of questions is generally around 2. This indicates positive agreement with most items in the survey. For example, the question for the first category (Website), "Overall, it is well designed" received a rating of 2.14 with approximately 75 percent of the participants indicating agreement or strong agreement with this statement. The mean score for most items under the Instructor category were favourable. Finally, Item 23, which asks about the usefulness of subject matter, received the most favorable rating in the entire evaluation (1.7).

The results presented above are by no means exhaustive in addressing the research objectives stated in chapter 1. However, they are interpreted in the context of the opportunities and constraints imposed by the design methodology adopted in this study. These are discussed in Chapter 6.

CHAPTER 6
DISCUSSION
Introduction

The topic of this study presents a double challenge to educators. The first challenge calls for the design, implementation and validation of theoretically robust courses. The second calls for significant technology integration into instruction in order to take advantage of its enabling qualities. These challenges have been contextualized in a relatively new instructional medium – the World Wide Web. It is argued that this medium has transformative properties that open new doors to designers, researchers, practitioners, and learners. Results of this study support this claim, in that theory-based tools assembled in a technology-rich environment have produced intended learning outcomes. Given its inherent tracking abilities, the medium also enables insight into the learning process. This study attempts to document the steps that have been taken to address concerns for aligning prototype technology solutions with instructional goals, pedagogy, and assessment.

Following the framework of development research, the study proposes a solution to the above-mentioned challenges. This is accomplished by conceiving a course in *Personal Finance*, grounding its design principles in theory, developing a generic learning model, testing the influence of variables, and presenting participant reactions from the beginning till the end of the course.

This chapter begins with a discussion of findings from Chapter 5. Components of the Integrated Learning Model (ILM) are summarized and depicted pictorially as a general model for web-based instruction. Variables influencing each component are revisited in order to clarify their role in the ILM and to increase our understanding of the theoretical and pragmatic concerns that face practitioners involved in crafting Web-designs that produce meaningful learning outcomes. In addition, survey results are highlighted. Some point to limitations of the study; others point to new directions that strengthen the future development of the ILM.

In addition, the inseparability of instruction and assessment is discussed in the context of the ILM. Using Salomon's (1991) systemic framework, developers are encouraged to take their educational programs further and to allow researchers to refine problems, solutions, and methods. Finally, the contribution of this study is discussed with respect to the goals identified in Chapter 1. As well its relevance with regards to recent concerns raised by leaders in educational research is explored. The theoretical and practical implications of the study in terms of its limitations and future directions are also presented.

The Integrated Learning Model

Paradigms and Concepts

While sharp distinctions between cognitive and social approaches have historically divided educational research efforts with respect to learning, these distinctions have lately become somewhat blurred (Anderson, Greeno, Reder, and Simon, 2000). The paradigms of knowledge acquisition, knowledge construction and situated cognition have much in common. Novel approaches to instruction are beginning to adopt a more pragmatic epistemology that borrows elements from each paradigm to form a coherent whole, and in order to build on the designer/instructor's personal experience, beliefs and values. In this study, the development of the Integrated Learning Model follows this multi-paradigmatic approach.

Consider, for example, the overall design principles discussed in Chapter 3 that were based on the characteristics of open-ended learning environments. Open-ended learning environments were selected because they accommodate tenets of situated cognition, knowledge construction, and knowledge acquisition strategies. These tenets are manifest in learning activities that include practice opportunities aimed at developing declarative and procedural knowledge, just as other activities emphasize knowledge construction within a community of learners scaffolded by peers and experts.

Using a multiple paradigmatic approach, a Web-based instructional model consisting of three principal components, namely, Knowledge Acquisition, Practice Effects and Assessment Components was conceptualized. Exploratory factor analysis was used to refine items that exhibited strong psychometric properties. Structural Equations Modeling techniques were used for confirmatory analysis emphasizing model fit and parameters loadings to explain the overall construct of learning.

In addition to its principal components, the Integrated Learning Model is based on three theoretical concepts that currently enjoy widespread recognition in the educational literature. These include expertise, pedagogical content knowledge, and self-regulation. These concepts can also be viewed as principles that serve as anchors for instructional designs using the World Wide Web. While these principles have traditionally been operationalized separately in classroom settings, they have not been emphasized simultaneously to constitute the core elements of an open learning model. The ILM represents such a synthesis.

In the ILM, the *principle of expertise* benchmarks standards for the subject matter or practice. It also introduces learners to multiple perspectives and engages them in tasks that lead to the next stage of development. Experts know how to represent problems effectively and how to nurture participants through conditions of effective practice. Experts are also skilled at creative assessment, where opportunities are provided for the learner to develop arguments, to reason and to demonstrate understanding.

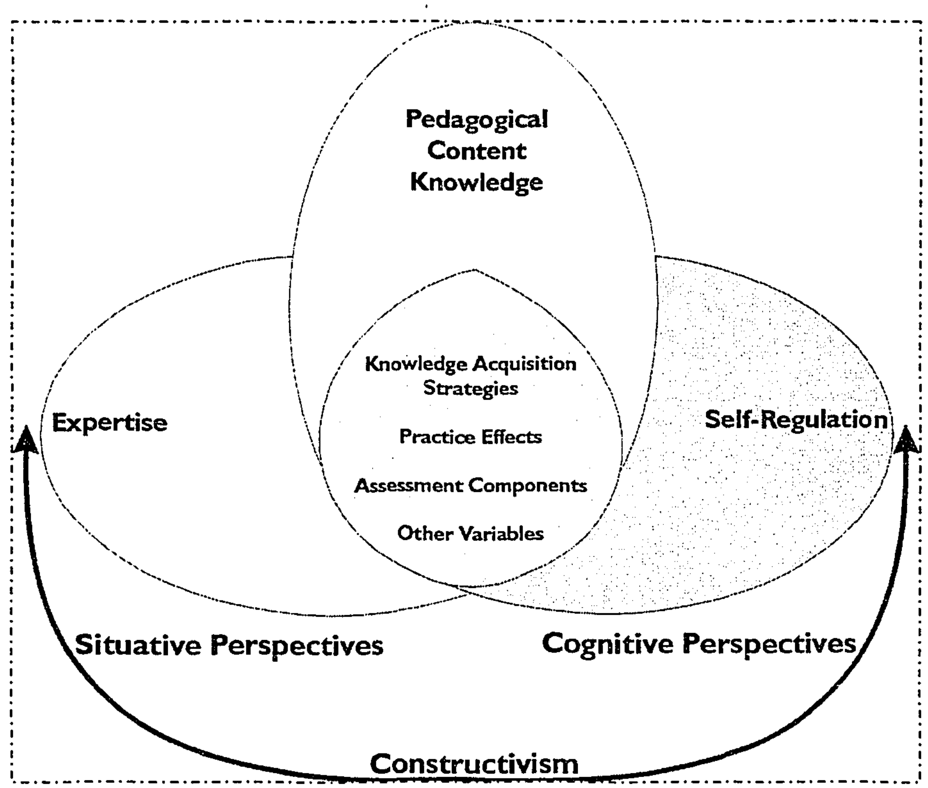
The principle of *Pedagogical-content knowledge* assumes years of experience and insight from knowing and understanding teaching as a craft. This craft honors multiple ways of representing and formulating content to make it comprehensible to others. These formulations are constantly revisited, altered, and fine-tuned thereby adding to the cumulative wisdom of the expert, which gets embedded into practice. This knowledge is easily recognized when it is experienced and it is generalizable as much as other forms of scholarship when examined in context. For designs to serve their purpose, which in most cases is to promote deep learning, pedagogical-content knowledge is a necessary and active ingredient.

The *principle of self-regulation* offers a repertoire of meta-cognitive activities and resources that influence academic learning. It emphasizes tasks that promote reflection. Self-regulation is a design principle because it attends to individual differences and specific characteristics of the learner. For example, designs that provide opportunities for participants to regulate their behavior vis-à-vis their peers and faculty, or interventions that impact on their study environment, promote discrepancies that the participant must strategically monitor. In addition, participants must adapt to the demands placed by the course. Their motivational beliefs and affective reactions are influenced by opportunities provided by the design of the course.

The ILM views these principles simultaneously as the glue that holds together design elements and activities emphasized in open-ended learning environments (see Figure 6.1). The anchors and core components are representations for instructional designers and practitioners to engineer learning solutions for the intended audience. The World Wide Web also represents an accepted choice for open learning environments.

Figure 6.1

Integrated Learning Model in an Open-Learning Environment



As illustrated in Figure 6.1 above, multi-paradigmatic elements of situated, cognitive and constructivist perspectives of learning embrace the entire model. In addition, the model emphasizes the WWW as the medium for open-learning representing rich design configurations and opportunities for course developers and for data collection and research. Also evident are three overlapping anchors, namely expertise, pedagogical-content knowledge, and self-regulation that have a common core characterized by the principle components of the model. These anchors are primarily attributed to instructors in order for them to unite appropriate design approaches. Thus, an instructional model is embedded within an environment that encourages learning. At the heart of this model, the principal components for learning to occur include five items that measure *knowledge acquisition*, four items that measure the *practice effect*, and six items that represent *assessment components*. Other variables are also identified that influence the overall construct of learning. These four dimensions of the ILM are discussed below.

Knowledge Acquisition

Traditionally, educators have implicitly or explicitly designed instruction to enable learners to use strategies to acquire acknowledge (Anderson, 1983; Farnham-Diggory, 1994; Holyoak and Spellman, 1993; Mayer, 1992). The locus of knowledge acquisition has generally been the classroom and instructor-centered approaches have been the focus of educational practices and research efforts. These approaches rely on the instructor for his/her subject matter expertise. The instructor is central to the delivery of materials and pedagogical activities.

In contrast, a learner-centered approach supports multiple cognitive tools and activities that attend to differences between learners. The differences between instructor and learner-centered approaches are profound and paradigmatic (Barr and Tagg, 1995). With respect to design, the emphasis is on the creation of very different learning environments. The designer/instructor must contend with different roles that include collaboration, identification of distributed expertise and an emphasis on coaching models like cognitive apprenticeship. The learner, on the other hand, works with the cognitive tools emphasized by the design.

Based on the SEM analysis, the ILM included five items that received high loadings that explicate knowledge acquisition strategies used by learners in *Personal Finance* (see Table 5.6). First, NOTES captures participant responses to the statement "Made personalized chapter notes" for each topic in the course. Note taking was emphasized as a reflective device that integrates and refines new material encountered in the course.

Second, VIDEO indicated the frequency of times participants watched videos. Some educational programs have anchored critical instructional activities around video segments, (see the Cognition and Technology Group at Vanderbilt, 1992; 1996; Vye et al., 1998). *Personal Finance* used videos to purposefully humanize the Web and to provide meaningful and deeper contexts in order to interpret how the subject matter was being applied in practice and how it affected the lives of participants. This medium has much potential that can be further exploited by thoughtfully integrating its attributes into meaningful, authentic tasks for the learner. Videos that tell stories are especially amenable to discussion threads and can be simulated to promote active learning. They can lead to vicarious experiences that need to be aligned with print material and other sources of information made available to the learner. As mentioned in Chapter 5, videos represented one of the many cognitive tools that contributed towards learning gains in *Personal Finance*.

The third variable, CHAPTER, asked the participants whether they had read the chapter(s) corresponding to the topic they were learning. Assigning appropriate reading materials may seem trivial given the content expertise of the pedagogue. However, inappropriate print-based tools interfere with comprehension given differential levels of prior knowledge of the learner. This mismatch results in learners' tuning out or mindlessly scanning reading material, thereby acquiring inert knowledge for its own sake (Dewey, 1904/1965). On the other hand, print-based tools should strike a balance between levels of difficulty, different points of view, variety of sources and alignment with other cognitive tools.

The fourth variable, AXIOMS, asked whether participants had read these as they appeared under each topic. Axioms represent the conceptual foundation for the practices valued by subject-matter experts. Different sets of axioms were presented under different topics to indicate how these were tied together and how they could be applied in multiple contexts. For example, *time value* is a core concept that can be presented graphically, explained in words or applied in problem-solving situations. One underlying objective of effectively representing *time value* is to ensure that participants understand how financial assets are priced in the marketplace. This understanding also determines how risk is priced and how extraneous variables affect it. *Time value* also plays an important role in various economic decisions that the participant has made and will continue to make. Thus, Axioms represent deep concepts that cut across several topics and that can be represented in multiple (conceptual and applied) ways so as to reveal powerful facets to the learner.

The fifth variable, FACTS, were statements that accounted for, or were descriptive of, information that related to typical financial situations. For example, under the topic of Financial Planning, one of the FACTS compared the lifestyle decisions of a couple with children to an individual who opted to stay single. These decisions were translated into economic terms (dollars) to provide a tangible sense of what they might entail. Thus, comparing the cost of sending children to College (for the couple) versus buying a cottage (for the individual) was presented as FACTS. However, this information raises broader issues about values, tradeoffs, and opportunity costs. It also presents information that may trigger plans and actions that are meaningful to the participant.

Given the data that were collected, the ILM highlights five knowledge acquisition strategies that learners took advantage of. The point is not about specific canned strategies that designers must use to ensure knowledge acquisition. Rather, it is about engineering an environment that ensures knowledge acquisition for meaningful learning to take place. Expertise and pedagogical content knowledge in the subject area, as well as reflective activities, are pre-requisites in outlining the nature and boundaries of knowledge acquisition strategies that will be used.

The Practice Effect

The expertise literature makes it clear that experts' knowledge becomes proceduralized, or compiled, in a condition-action form (Anderson, 1983), and that experts develop "automaticity" through repeated practice (Ericsson, 1996). The implication for design is also clear, in that knowledge development requires appropriate conditions for effective practice. Practice opportunities can be exploited for the scaffolding and reflection opportunities they afford (Jackson, Stratford, Krajcik, and Soloway, 1994). For example, in *Personal Finance* initial dialogue amongst peers is encouraged, with expertise strategically distributed so that guiding and scaffolding interventions are always available.

Distributed properties are a hallmark of the Web (Pea, 1993). Brown (2000) has emphasized these properties, which include design tools, content expertise, and learning opportunities, as the ability of the Web "to leverage the small efforts of the many with the large efforts of the few." In this environment, cognitive tools play a mediating role in providing opportunities for problem solving as well as guided and deliberate practice on certain aspects of performance. This results in not only improving competence, but also freeing up cognitive resources for higher-level processes (Salomon, Perkins, and Globerson, 1991; Zeitz and Glaser, 1996).

In the ILM, four items that received high loadings explain the Practice Effect in *Personal Finance* (Table 5.6). First, PRESCORE reflects the average score on Pre-Tests designed for each topic in the course. The Pre-Test was recommended as the first step in sequencing learning activities for participants. A low score on the Pre-Test provides a rough indication of the learner's prior knowledge, thereby presenting an opportunity to reflect on the amount of additional effort required in improving the score.

Additional effort can be spent on knowledge acquisition strategies described earlier, with effectiveness confirmed by a variety of practice opportunities made available on the Web. In *Personal Finance,* in addition to the Pre-Test, open-ended review questions, mini-cases, worksheet simulations and assignments provide vehicles for deliberate forms of practice. Because of limitations in this study, data were not gathered for each of these cognitive tools. However, analyzing tool use would likely further explain practice effects. Differences could highlight the relationship between specific practice tools and different taxonomies of learning.

Similarly, the second item, POSTSCOR (which had a very high factor loading of 0.96) reflects the average score on Post-Tests designed for each topic in the course. The Post-Test is identical, in terms of format and difficulty, to the Pre-Test. It serves as a checkpoint to the learning effort expended with other cognitive tools once the Pre-Test is attempted. It can be expected that participants who scored low on the Pre-Test and went on to engage in knowledge acquisition strategies and practiced with the appropriate cognitive tools would see an improvement in their score on the Post Test.

The third and fourth items labeled "PRENUM" and "POSTNUM" are indicators of the number of times different Pre-Tests and Post-Tests were attempted. Higher frequencies of practice on different types of tests explained why participants were able to achieve the learning goals in *Personal Finance.* Again, had similar data been gathered for other practice tools, additional insights could be gained and explanations regarding tool use could be given.

Practice tools identified in the ILM are not meant to represent prescriptions in terms of the nature and composition of each tool that is necessary for learning to take place. The appropriate configuration of true/false, multiple-choice, and open-ended questions, the complexity of simulations and the nature of discourse encouraged in discussion are once again influenced by the design anchors of the ILM described above. These anchors will reflect the particular expertise of the instructor. They will also reflect his/her pedagogical content knowledge, and the degree to which self-regulatory activities are woven together. The strength of these anchors will depend on the degree of collaboration between the instructor, and other important players in the design team. Nevertheless, the main point is that any design must present practice opportunities to learners that are commensurate with the goals valued by the designer/instructor.

In the ILM, practice opportunities are also intertwined with knowledge acquisition strategies and each complements the other. Participants value access to subject matter knowledge as multiple representations (Mayer, 1994; 1997). This is partly because they have tool preferences and different learning styles. On the other hand, practice opportunities run parallel with these representations, providing feedback and self-regulating opportunities (Winne, 1992; 1997). They serve not only to activate internal conditions of learning by engineering external conditions, but also to link cognition and context simultaneously. These integrated and embedded states of Practice Effects also afford opportunities for continuous assessment.

Assessment Components

At various points during the learning process, milestones appear, showcasing student knowledge and levels of development that need refinement until student work can stand on its own (Biggs, 1999; Calfee, 1993; Derry, Gance, Gance, and Schlager, 2000; Goldman, Pellegrino, and Bransford, 1994; Lajoie and Lesgold, 1992; Shuell, 1992). These milestones represent assessment components, which describe the third component of the ILM.

Six items representing high factor loadings explain the composition of the assessment construct used in *Personal Finance* (Table 5.6). First, FEEDBACK captures a group effort whose purpose is to strengthen the critique of another group. The benefits of peer tutoring and feedback as self-regulating devices that generate meaningful learning are well documented (Butler and Winne, 1995; Issroff and Del Soldato, 1995; Merrill, Reiser, Ranney, and Trafton, 1992). The group interaction is multiplied by the Web's ability to simultaneously showcase all participants' work-in-progress. In *Personal Finance*, over ninety groups posted their initial drafts for all to see. Each group benefited from peer feedback while experts intervened to highlight exemplars and suggested changes that addressed common errors or misconceptions amongst participants. Guidelines were provided for ways to strengthen feedback. The results of these incremental refinements and multiple views were reflected in the second item CRITIQUE. Final representations of successive improvement reflected in the Critique were published on the Web.

The third item, ARTICLE, represents the ability of the learner to research valid sources of information, evaluate their authenticity, establish their merit and find connections that are personally meaningful (Bartasis, 1995). Again, exemplary articles and Web sites are highlighted, and experts intervene to provide hints and general comments that provide opportunities for reflection and improvement.

The next item, MIDTERM, takes stock of the participant's progress by emphasizing activities that were valued and tests for knowledge acquisition and practice effects. This milestone has the ability to raise the performance bar by integrating disparate materials, concepts, problem-solving sets, cases, and simulations to demonstrate how they synthesize and evaluate at relational and extended abstract levels. (Biggs, 1996; 1999). For many educators, the idea of the mid-term exam is commonplace. However, in some instances exams are recycled devices representing a new set of standards that participants have never seen or had a chance to prepare for (Merrill, 1992, Morey, 1992). This misalignment can be fatal in terms of creating cognitive blocks that hinder future progress. On the other hand, an evaluation that is consistent with authentic learning activities and practices that have engaged the learner builds confidence and invites him to continue with the course on a long-term basis.

The fifth item, ASSIGN, is explicitly designed to provide additional flexibility to the learner. Participants are encouraged to select from different choices that are consistent with the cognitive tools designed for knowledge acquisition and practice effects. In *Personal Finance,* one assignment leans towards quantitative problem solving while another presents a case that is rich in context in terms of developing a situation that must be managed. The third choice presents a different kind of application, one that the participant faces each year when preparing his/her tax return. For each of these choices, in addition to clear criteria and guidelines that make the task doable, exemplary work from prior semesters is showcased.

The last item, FINALEXA, is the summative measure of many activities valued throughout the course. The final exam presents an opportunity to raise the level of performance in terms of assessing a range of designed learning activities including higher-level learning outcomes. Once again, the designer/instructor must carefully align learning goals with the final evaluation and strike a balance when challenging the learner to demonstrate his/her strengths (Biggs, 1999). A learner-centered design will attend to flexibility and choice and provide the participant with multiple opportunities to demonstrate his/her learning (Cox, 1997).

Thus, when the learning contract is a negotiated commitment to move forward between a community of learners, old practices need to be abandoned and new collaborative and cooperative principles need to be adopted. For example, instructors should not settle for a normal grade distribution that follows a competitive model where the fittest excel, the majority is considered average and a reasonable percentage is expected to fail. Most participants deserve to achieve a mastery of the goals set at the outset. Well-designed assessment procedures must ensure that early warnings are built-in to reveal which tools and accompanying processes are ineffective and which ones enable outcomes that are valued.

All three core components of the ILM must be aligned. Knowledge acquisition strategies and practice opportunities provide learners with multiple ways of processing and producing learning outcomes (or assessment components) when design components are constructively aligned (Biggs, 1999). In *Personal Finance,* multiple objectives outlined in Chapter 3 are continuously being assessed, with activities designed to capture outcomes as they occur throughout the course. For the ILM, it is not the specific types of assessment components used in *Personal Finance* that matter. What matters is the fit between objectives, tools, practice opportunities, and assessment components. Once again, the quality of assessment components will ultimately be a function of the design anchors behind the ILM. Expertise, pedagogical content knowledge and reflective practice will influence assessment choices, their inclusive qualities and inherent flexibility in accommodating the many faces of the learner.

Whereas three core components of Web-based instruction have been outlined in the ILM, there are other factors that may add to its core and many other items that can wrap around it. The ILM offers a tentative explanation of the underlying general construct of learning which remains as a universal, multifaceted and highly complex phenomenon. Some of these other variables are explored below.

Other Variables

In *Personal Finance*, four items were identified as external variables that influenced learning. The first two include the amount of time participants spent on the Web and the number of times they logged onto the Web. This result is logical in the same sense as class attendance is assumed to influence learning outcomes. However, it is not that clear how much time should be spent or how often the learner should log on for learning on the Web to take place. The surveys indicated that the majority of participants spent up to six hours a week. However, the distribution of time spent was skewed, as 20 percent spent between 10 and 25 hours, and 15 percent spent over 25 hours per week. On the Web, one might hypothesize that the learner has more control over his time, but this issue requires further analysis.

Furthermore, some designers tend to assume that learners will spend a great deal of time on the Web as long as interactive time-on-task activities or learning resources are made available (Bonk and Cummings, 1998; Khan, 1997). This was not the case for *Personal Finance*. As mentioned above, the distribution of time spent is fairly skewed. In addition, many students procrastinated and worked in spurts, just as they do offline. Brown (2000) reveals that digital learners have different skill sets and attend to learning resources in different ways. They tend to "multi-process" efficiently, possess image and screen literacy and are comfortable navigators through confusing, complex information spaces. However, future studies need to examine the factors that explain how learners allocate time given the affordances and constraints of the Web.

Despite this lack of information, it seems intuitive that undergraduate or novice learners generally exhibit poor time management skills and would benefit if minimum standards of time and frequency were established in order that they may regulate their pace and plan accordingly.

The third variable, Faculty of Origin, is an indication of prior knowledge. Unlike the Pretest variable, which measured the practice effect, the assumption in *Personal Finance* is that participants in the business faculty will perform better in business courses, just as engineering students will perform better in engineering courses. On the other hand, it can be argued that in the case of *Personal Finance*, which is an elective course offered at the introductory level and aimed at the broadest possible audience, faculty of origin should not make a difference. This question needs to be further explored and analyzed in terms of differences between the groups of students representing different faculties. Further research on assessment procedures across faculties, or between different sets of knowledge acquisition tools traditionally used in different faculties, could reveal important differences.

Familiarity with cognitive tools also assumes proficiency with technology. This fourth variable is statistically significant as a parameter that partially explains the overall construct of learning on the Web. Lack of proficiency with technology could rob the learner of valuable cognitive resources required for knowledge acquisition and practice. It can also create negative impressions that remain long after the experience with technology is over. High attrition rates commonly reported in the distance education literature are often associated with proficiency issues especially when the course or program does not address the proficiency needs of the learner (Nixon and Leftwich, 1998; Vrasidas and McIsaac, 1999).

In *Personal Finance* survey responses indicated that for the majority of participants basic proficiency with computers, navigation on the Internet, etc., was not an issue. Most were also familiar with communication tools and took advantage of their inherent features. Surveys also revealed generally positive preferences for all of the cognitive tools selected for the course. In addition, participants indicated changes in frequency with respect to the use of print-based materials, interactive practice tests, online information, videos and communication software, especially when these tools helped them to accomplish different tasks. For example, print-based tools were ranked higher than videos, probably because they enabled participants to improve their scores on practice tests, which were emphasized in the assessment components. This does not mean that Web based learners generally prefer print-based tools to visual tools. However, the surveys did not reveal the degree and skill with which these cognitive tools were used in order to effectively learn the tasks that required their use.

Again, there needs to be further exploration of tool use as it relates to the stages of learning development. Alternately, correlations between different types of tools and learning taxonomies can provide important insights on the deployment of different cognitive tools. For recent developments in this important line of enquiry see Derry, Gance, Gance, and Schlager (2000).

Intuitively, design features should emphasize support mechanisms that overcome technical problems and familiarize learners with important features of software, tool use, and effective ways to navigate the Website. Minimum proficiency skills can be regarded as a pre-requisite to technology-intensive courses. Participants should be given a proficiency test and remedial help, or be informed in detail as to what the proficiency requirements are.

The Inseparability of Instruction and Assessment

Moving towards open-ended, theory-based Web learning environments also implies that we move away from traditional forms of assessment. Traditional forms emphasize standardized tests or individual work that are products of factual knowledge and discrete skills, which are generally not effective diagnostic aids. However, the ILM is performance based. Topics are not learned in isolation, but are anchored and situated in authentic problem-solving environments with multiple opportunities for reflection and self-regulation. Tasks include both individual and collaborative means of enquiry.

Glaser, Lesgold, and Lajoie (1987) argued that Intelligent Tutoring Systems (ITS) provide an ideal laboratory for investigating new assessment techniques because such tutors are *driven* by assessment of individual student knowledge. Thus, someone who has learned to solve problems, to make inferences, and to be skillful in a subject matter domain has acquired knowledge structures that enable actions that influence learning, goal setting and planning. The ILM mirrors some of the elements of an ITS framework. Its strength lies in assessment dimensions that deal with knowledge and skill according to various dimensions of performance, such as degree of structure, feedback opportunities, automaticity, etc., which indicate the development of competence.

While many designs regard assessment as an independent step separable from other instructional events, the ILM considers assessment as an integral part of instruction. This is because assessment is a function of the open-learning system's diagnostic capabilities. This implies that information relevant to the process of learning in a domain can be recorded and preserved to provide a continuous record of change in knowledge, skill, and understanding as students encounter problems of increasing complexity (Derry et al., 2000; Frederiksen, Glaser, Lesgold and Shafto, 1990; Lajoie and Lesgold, 1992).

Similarly, Brown, Collins, and Duguid (1989) demonstrated the cohesion between the problem, context, and solution, generalising that by providing more naturally embedded activities, students can more easily draw their own conclusions. Royer, Cisero, and Carlo (1993) have argued that cognitive skill itself needs to be assessed, which implies that the learner's status in developmental terms needs to be identified. Assessment also focuses on qualitative aspects such as changes in the organization and structure of knowledge and the fluency and efficiency with which knowledge can be used. These views are consistent with the goals of the ILM, which promote critical thinking skills, deep knowledge, and multistructural and relational forms of learning.

From the perspective of useful research outcomes resulting from the ILM, a systemic approach was applied to discern patterns of inter-relationships that actually happened under normal instructional conditions. This follows Salomon's (1991) conclusions that assessment needs to be both analytic and systemic since each approach complements the other. While the analytic approach capitalizes on *precision* by concerning itself with discrete variables and their effects, the systemic approach capitalizes on *authenticity* by concerning itself with a holistic setting of interdependent events. Each, given its strengths, "serves a different purpose, addresses different issues, asks different questions, and employs different methodologies" (Salomon, 1991, p. 16.)

The systemic approach raises new questions and provides new hypotheses, some of which may best be addressed by analytically guided studies (Lajoie, 2000). These questions, as well as those arising from participant responses to questions, are raised in the following sections.

Original Contributions to Knowledge

This study has made several contributions to the body of knowledge in instructional and cognitive psychology and in particular to Web-based designs. First, the study has successfully responded to the urgent call from educational leaders for the need of theory-based designs that improve our understanding of systematic factors that influence learning in technology-rich mediums (Clark and Estes, 1999; Cross, 1998; Reeves, 2000; Schoenfeld, 1999). This urgency is viewed in the context of proliferating designs in a new instructional medium that is considered to have transformative properties and the potential to affect millions of learners (Brown, 2000). This case study effectively responds to these concerns by presenting a theory based, technology rich online course, highlighting principles and constructs that enable and enhance student learning.

Second, this study provides a methodology that operationalizes a pedagogical framework on the Web. It presents a complete design experiment from conception to implementation of a Web-based instructional learning system, along with empirical research and support for intended learning outcomes. The study proposed a conceptual Web-based instructional model and used systematic procedures to validate it. While design experiments are not new, the procedures used to develop a measurement construct in a Web-based environment as well as the confirmatory analysis used for model fitting, open new doors for future researchers.

Third, this study extracts from the educational literature three powerful concepts that serve as design anchors for other model configurations. These anchors, labeled principles of expertise, pedagogical content knowledge and self-regulation, are the active ingredients that must be considered simultaneously for meaningful, generative learning to occur. They have been synthesized to represent perspectives from both learning and instruction. They provide a guiding framework that can be used to promote effective designs of Web-based instruction. They are generalizable as necessary principles in future modeling, to the extent that the beliefs and values of designers and instructors are consistent with the multi-paradigmatic approach used in this study. This integrative approach is echoed in a recent issue of *Educational Researcher* by Anderson, Greeno, Reder, and Simon (2000) who conclude:

> A high priority should be given to research that progresses towards unifying diverse perspectives within which we currently work, both because this is scientifically important and because this will increase our usefulness of our findings for informing public debates about educational policy and practice. This scientific work can be productively competitive, as scientific work often is, depending on the formulation of strong hypothesis and claims by the proponents of multiple perspectives and theories, as well as strong challenges to those claims and critical evaluation of the significance of evidence that is presented. (p. 13)

Fourth, this study bridges paradigmatic gaps by blending the strengths of cognitive and situated perspectives. Similarly, the study uses constructivist principles, but is not shy to admit to structured approaches in engineering a design that accommodates novice learners by providing multiple perspectives and diverse backgrounds. In addition, this study emphasizes a pragmatic epistemology, using open-learning environments mixed with guidance and intervention to promote different combinations of the three design principles.

Furthermore, the study provides numerous examples of the importance of constructive alignment between the different design elements so that the entire system is viewed as a pattern of relationships where no element functions apart from the series to which it belongs. This study validates a robust Web-based Integrated Learning Model that conceptualizes three core constructs based on these design anchors. These core constructs represent strategies of knowledge acquisition, practice opportunities and assessment components and form the basis of measuring the learning construct. It also provides insights on learner characteristics as these relate to their prior knowledge, motivation, proficiency with technology and preference for tool use. Although this profile provides a rough sketch of an on-line learner, it bids researchers to further investigate these and other dimensions that will increase understanding of how to better design technology-rich learning environments

Finally, this study represents a large-scale systemic evaluation of a theory-based Web design using constructs that can be replicated. This approach can be generalized to new uses of Web-based designs in higher education. It also invites programs of research using analytic approaches that refine our understanding of critical variables that influence meaningful learning on the Web.

Limitations of the Study and Implications for Future Development

The major limitation of this work is that it is a case study. Although the evidence presented in this study may be defended on its usefulness, contextual completeness, interpretive validity and trustworthiness (Altheide and Johnson, 1994; Gall, Borg, and Gall, 1996), questions based on the reliability of using self-reported data as it emerges from various data-tracking instruments remain. The timing of responses from participants to a battery of questions that were administered, as well as the conditions under which questions were responded to, are unknown, and could therefore have biased the nature and direction of the results. Furthermore, the configuration of design tools and instructional strategies that have led to stated learning gains offers one case among many with uncertain outcomes.

Secondly, while the overall model and its fit characteristics appear to be fairly robust, several other potential dimensions were not included because of a variety of constraints. For example, in defining practice opportunities, actual data from several other tools that were frequently used was ignored. Semantic analysis of discussion comments, or qualitative analysis of cases and open-ended questions was not performed.

Third, the study does not identify how different tools contribute to different taxonomies of learning. In addition, proficiency with the technology profile of the participant is incomplete and few conclusions can be drawn for application to other learning situations. Other related issues relating to time management, learner control, learning style, and other differences between learners, requires further enquiry and analysis (Dillon and Gabbard, 1998).

Fourth, little attention was given to the motivational factors that drive learning online. While the surveys indicated that learners selected the course because they were enthusiastic about what they would learn and, more importantly, what they perceived the value of the topics to be in their personal lives, further enquiry into motivational tactics online (Del Soldato and Du Boulay, 1995), intrinsic and extrinsic rewards (Lepper, Keavney, and Drake, 1996), and collaborative aspects of learning (Dillenbourg, Mendelsohn, and Schneider, 1994; Issroff and Del Soldato, 1995) needs to be pursued.

On the cognitive level, researchers are exploring visual literacy and attempting to demonstrate that different symbolic forms of representation are processed by different mental skills (Eisner, 1997; Greeno and Hall, 1997; Mayer, 1997; Salomon, 1997). These efforts need to be better understood by educators in order to design and integrate different multi-media formats in their instruction.

Broader questions that might be examined in the future regarding the development of integrated learning models are equally pressing. For example, the impact of *Personal Finance* or any other technology-enriched course must be examined at the curriculum level and within the entire program offerings. There are implementation issues to consider, as there are questions about how collaborative efforts that strive to achieve synergy and avoid duplication need to be structured. As well, there are consequences of technology integration that must be isolated and explored and the unintended effects minimized.

Technology integration causes a ripple effect in the entire educational system that affects both the teacher and the learner in terms of how they view their respective roles. Web-based instructional systems are vehicles for a different conceptualization of education and different ways of dealing with knowledge. Macro approaches that instantiate new pedagogical approaches must aim to solve new kinds of problems and instill new skills amongst learners. This requires new conceptions of what instructors want to see in their students. This vision will determine the role the Web can play in creating a community of learners that can intelligently solve different kinds of problems. Thus, the future direction of studies like this is closely tied to the potential uses that educators and developers see in exploiting the Web.

Implications of Web-based Instruction in Higher Education

Historically, we have witnessed the impact of fundamental changes in various technologies as they have transformed society at large. However, the university's basic technology has remained fairly stable in terms of storage, retrieval and transmission methods, although the introduction of departments in the 19th century was a major change in terms of labs, discipline-based literature, journals, etc. (Massey, 1997). With the advent of the Internet and the World Wide Web, this stability has been irreversibly and structurally altered regardless of whether those in the educational community join or resist these technologies (Brown, 2000; Cole, 2000; Khan, 1997; Massey 1995, 1997; Oblinger and Rush, 1997).

The implications of new technologies in higher education mainly concern productivity in terms of the quality of scholarship and learning (Oblinger and Rush, 1997). However, for those employed within universities, the size of faculty and administrative units, their commensurate roles and rewards, how resources will be allocated, etc., are important questions. The pragmatic faculty member is concerned about learning new roles that are being advocated as a result of integrating technology in their courses. Web-based instruction clearly implies a shift from content expertise to design expertise. It also implies new forms of scholarship including the ability to integrate, apply, model, mentor, collaborate, and manage – each of which requires human intervention and contact.

The pragmatic administrator is concerned with attracting new learners, with infrastructure and cost and with process reengineering efforts at different levels in the university (Massy and Zemsky, 1995). Web-based instruction poses as many challenges as it does opportunities. As indicated in this study, the main implication is how to leverage faculty labour with technology and not how to replace it.

The pragmatic employer is concerned about knowledge workers and life-long learners to the extent that they are willing to appropriate the higher-education market, what was traditionally the exclusive domain of colleges and universities. Web-based instruction implies modularized courses that develop the kinds of skills valued in the workplace such as applied projects, apprenticeship, dynamic content, team learning, and familiarity with communication technologies (Marchese, 1998; Roberts, 1998; Ruch, 1999).

The pragmatic learner is concerned with access, cost and flexibility. They are also concerned about taking charge of their learning. Web based instruction offers learners the opportunity to construct and take ownership of their learning (Reeves, 1997). It also offers the potential to enhance their role in a community of learners that has no geographic boundaries, and select knowledge acquisition strategies that suit their learning styles.

From a systemic viewpoint, when theory-based robust models of Web-based instruction embedded with cognitive tools are deployed, each of the players mentioned above stands to benefit. This is because Web technology has enabling features that allow faculty, administrators, employers and learners the chance to exploit their comparative advantage. For example, the Web affords faculty additional opportunities to spend their valuable time thinking about teaching methods and the kinds of intellectual enquiry that drew them to the profession in the first place (Moore, 1994). It relieves them of the repetitive drudgery commonly associated with traditional lecturing and allows them to deal with a better-prepared audience that has access to distributed expertise (Massey, 1997).

Summary and Conclusions

The ILM was introduced to encourage designers of Web-based instruction to engineer appropriate knowledge acquisition strategies and practice opportunities that are aligned with learning goals valued by the instructor and his discipline. For design purposes, complementary sets of practice tools provide excellent opportunities for self-regulation and an audit trail for selective interventions. Knowledge strategies and practice effects have many configurations, but must fit together to form a whole greater than its parts. The ILM also represents a third component that emerged as a strong construct of the model. This construct captures the artifacts of learning, labeled Assessment Components. These components reflect stages and milestones of learning that were produced during the learning process. Once again, these components must be aligned not only with learning goals, but they must be consistent with the choice of tools that enable knowledge acquisition and practice effects. Finally, the ILM encourages the designer to consider other sets of variables that may explain why participants learn meaningfully and what might enable them to create knowledge. In this study, four external variables influenced learning. Two were related to the frequency and amount of time spent on the Web, the third was related to prior knowledge, and the fourth to proficiency with technology.

In the discussion it was emphasized that none of the specific sets of variables that constitute the core components of the ILM necessarily represent universal design elements that other Web-based models should emulate. On the other hand, the ILM encourages unique configurations of variables that appear as "clouds of correlated events" (Scarr, 1985) representing each of the core constructs identified in the model. What the model does offer are at least three core components engineered by individuals or teams that use the principles of expertise, self-regulation, and pedagogical content knowledge. These components *mutually* define each other and are inseparable in the ILM.

The results of this study represent a large-scale systemic evaluation of a theory-based Web design using constructs that can be replicated. This approach can be generalized to new uses of Web-based designs in higher education. Such Web-designs open new doors to faculty, administrators, employers, and learners. New roles and uses implied by theory-based designs such as the ILM expand the inherent capacity for all players to revisit their comparative advantage, so that the information age is regarded as "an epoch where higher education occupies a pivotal role in society" Dolence and Norris (1996).

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Appendix A

Preliminary Survey

Preliminary Survey – A Distance Education Course on Personal Finance

Centre for Instructional Technology, at the Faculty of Commerce and Administration, is trying to determine the demand for an introductory course on personal finance which could be available to students in all faculties through the Web. We would greatly appreciate it if you could answer the following questions. All answers will be anonymous and confidential. Thank you very much for your time and effort.

1. Please provide the most appropriate answer

a) What year are you in? ☐ 1 ☐ 2 ☐ 3 ☐ other (specify) ______

b) Sex: ☐ Male ☐ Female

c) Age:
- ☐ under 20
- ☐ 20-24
- ☐ 25-29
- ☐ over 30

f) Have you ever taken a distance education course? ☐ Yes ☐ No

g) Would you be interested in taking a course on the Web? ☐ Yes ☐ No

h) Are any of these aspects of web-based instruction / distance education appealing to you?
- ☐ Access
- ☐ Convenience
- ☐ Flexibility
- ☐ Other ______________________________

i) Where could you use a computer that has Web access? (Select all that apply)
- ☐ home
- ☐ school
- ☐ work
- ☐ other
- ☐ don't know

2. Circle your level of interest in these areas from 1 to 5 (1 is not interested and 5 is very interested)
Note: bracket information provides examples

		Not interested				**Very interested**
a)	Determining your financial plan (your budget, how much you are worth)	1	2	3	4	5
b)	Your credit (how much you can afford, managing credit cards)	1	2	3	4	5
c)	Sources of borrowing (student loans, commercial loans, effective interest rates)	1	2	3	4	5
d)	Tax planning (record keeping, filing a tax return)	1	2	3	4	5
e)	Renting vs. Buying (what is a mortgage, leasing a car or t.v. as compared to buying it)	1	2	3	4	5
f)	Risk Management Strategies (diversifying risk, portfolio management)	1	2	3	4	5
g)	Insurance – Life, Health, Property (types, characteristics, which are suitable for you)	1	2	3	4	5

Preliminary Survey – A Distance Education Course on Personal Finance

Centre for Instructional Technology, at the Faculty of Commerce and Administration, is trying to determine the demand for an introductory course on personal finance which could be available to students in all faculties through the Web. We would greatly appreciate it if you could answer the following questions. All answers will be anonymous and confidential. Thank you very much for your time and effort.

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a) What year are you in? ☐ 1 ☐ 2 ☐ 3 ☐ other (specify) ______

b) Sex: ☐ Male ☐ Female

c) Age:
- ☐ under 20
- ☐ 20-24
- ☐ 25-29
- ☐ over 30

f) Have you ever taken a distance education course? ☐ Yes ☐ No

g) Would you be interested in taking a course on the Web? ☐ Yes ☐ No

h) Are any of these aspects of web-based instruction / distance education appealing to you?
- ☐ Access
- ☐ Convenience
- ☐ Flexibility
- ☐ Other ______________________________

i) Where could you use a computer that has Web access? (Select all that apply)
- ☐ home
- ☐ school
- ☐ work
- ☐ other
- ☐ don't know

2. Circle your level of interest in these areas from 1 to 5 (1 is not interested and 5 is very interested)
Note: bracket information provides examples

		Not interested				Very interested
a)	Determining your financial plan (your budget, how much you are worth)	1	2	3	4	5
b)	Your credit (how much you can afford, managing credit cards)	1	2	3	4	5
c)	Sources of borrowing (student loans, commercial loans, effective interest rates)	1	2	3	4	5
d)	Tax planning (record keeping, filing a tax return)	1	2	3	4	5
e)	Renting vs. Buying (what is a mortgage, leasing a car or t.v. as compared to buying it)	1	2	3	4	5
f)	Risk Management Strategies (diversifying risk, portfolio management)	1	2	3	4	5
g)	Insurance – Life, Health, Property (types, characteristics, which are suitable for you)	1	2	3	4	5

Appendix B

Consent Form

Consent Form

I voluntarily agree to participate in completing online survey's administered in the web-based course "Personal Finance 499f" and understand that my responses may be used for research purposes. I understand that I can withdraw my consent at my own discretion and for any reason at any time. I understand that this survey is part of a research project that aims to improve the course and for the purpose of a doctoral dissertation.

Analysis derived from survey data is also meant to design and implement effective intervention solutions as they relate to the needs of the students registered for this course. I understand that my participation (or lack of it) in online surveys will have no bearing on assigned tasks that are evaluated for grades.

I also understand that my identity will be protected and that all records will be coded to guarantee confidentiality. Access to data will be limited to research investigators involved in the study.

Student ID number:

Date:

Student Signature:

Appendix C

Survey I - Questionnaire (Start of Term)

QUESTIONNAIRE (Anonymous)
Section I: LEARNER PROFILE

1. Personal information
   a) Age______
   b) Faculty
      - Commerce & Admin
      - Arts & Science
      - Engineering & Computer Science
      - Fine Arts
      - Other ______________________
   c) Gender
      - Male
      - Female

2. Which of the following environments is best suited to your learning style? Check one box
   - Discovery learning (you like to explore and learn independently but dislike structure & routine)
   - Guided instruction (you like structure & procedure and prefer to be told what & how to learn)
   - Mixture of both above

3. How would you assess your familiarity with:

	Very high	**High**	**Medium**	**Low**
a) using a computer?				
b) using the internet?				
c) using email?				

4. On average, how much time are you expecting to spend per week on this course?
   - 0 - 3 hours / week
   - 3 - 6 hours / week
   - 6 - 9 hours / week
   - Over 9 hours / week

5. On average, how much time are you expecting to spend per week logged on to the course website?
   - 0 - 3 hours / week
   - 3 - 6 hours / week
   - 6 - 9 hours / week
   - Over 9 hours / week

6. How would you rate your level of knowledge on issues in personal financial management?
   - Very high
   - High
   - Medium
   - Low

Section II: LEARNER MOTIVATION

	Very high	High	Medium	Low
7. Compared to other electives you have taken, how would you rate your enthusiasm for this course?				
8. Compared to other electives you have taken how difficult do you perceive this course to be?				
9. Compared to other courses you have taken, how would you rate the perceived value of topics in this course?				
10. How much effort do you anticipate investing in this course?				
11. What grade are you expecting to obtain in this course?				
12. How would you rate the importance of taking this course at a distance based on access and convenience?				

13. Rank the relative importance of the following that influenced your selection of this course:

[1 = Most Important 2 = Next most important .... 6 = Least Important]

Your enthusiasm	Level of effort
Degree of difficulty	Easy grade
Perceived value of topics	Access & convenience

Section III: INITIAL KNOWLEDGE

14. Considering your present knowledge of personal finance, how would you rate your ability to:	Very high	High	Medium	Low
i) explain common terms and basic concepts in personal finance?				
ii) articulate issues concerning the management of your money?				
iii) critique popular publications on personal financial issues?				
iv) critique views expressed in the media (radio and television) on personal financial issues?				
v) identify priorities relating to your personal financial plan?				
vi) make personal financial decisions?				

Section IV: TOOL USE

LEARNING TOOLS
1. Print Material
2. Videos
3. Online information
4. Communication software
5. Online Interactive Practice Tests

15. From the list above, select in order of your preference, three tools that you will enjoy using the most

    Most enjoyable

    Next

    Next

16. From the list above, select in order of your preference, three tools that you will least enjoy using

    Least enjoyable

    Next

    Next

17. From the list above, select **three tools** that you will use **most frequently.**

    Most frequent

    Next

    Next

18. From the list above, select **three tools** that you will use **least frequently.**

    Least frequent

    Next

    Next

LEARNING TOOLS

1. Print Material
2. Videos
3. Online information
4. Communication software
5. Online Interactive Practice Tests

19. From the list above, select **three tools** that you think will help you prepare the most for Tests

Most helpful

Next

Next

20. From the list above, select **three tools** that you think will help you critiquing an article

Most helpful

Next

Next

21. From the list above, select **three tools** that you think will help you the most in writing discussion comments

Most helpful

Next

Next

22. From the list above, select **three tools** that will help you the most in finding Articles/Websites

Most helpful

Next

Next

THANK YOU VERY MUCH FOR PARTICIPATING!

Appendix D

Survey II - Questionnaire (End of Term)

QUESTIONNAIRE (Anonymous)
Section I: LEARNER PROFILE

1. Personal information

   a) Age______

   b) Faculty
      - Commerce & Admin
      - Arts & Science
      - Engineering & Computer Science
      - Fine Arts
      - Other ______________________

   c) Gender
      - Male
      - Female

2. Which of the following environments is best suited to your learning style? Check one box
   - Discovery learning (you like to explore and learn independently but dislike structure & routine)
   - Guided instruction (you like structure & procedure and prefer to be told what & how to learn)
   - Mixture of both above

3. How would you assess your familiarity with:

	Very high	**High**	**Medium**	**Low**
a) using a computer?				
b) using the internet?				
c) using email?				

4. On average, how much time did you spend per week on this course?
   - 0 - 3 hours / week
   - 3 - 6 hours / week
   - 6 - 9 hours / week
   - Over 9 hours / week

5. On average, how much time did you spend per week logged on to the course website?
   - 0 - 3 hours / week
   - 3 - 6 hours / week
   - 6 - 9 hours / week
   - Over 9 hours / week

6. How would you rate your level of knowledge on issues in personal financial management?
   - Very high
   - High
   - Medium
   - Low

Section II: LEARNER MOTIVATION

	Very high	High	Medium	Low
7. Compared to other electives you have taken, how would you rate your enthusiasm for this course?				
8. Compared to other electives how would you rate the difficulty of this course?				
9. Compared to other courses you have taken, how would you rate the perceived value of topics in this course?				
10. How much effort did you invest in this course?				
11. What grade are you expecting to obtain in this course?				
12. How would you rate the importance of taking this course at a distance based on access and convenience?				

13. Rank the relative importance of the following that influenced your selection of this course:

[1 = Most Important 2 = Next most important .... 6 = Least Important]

Your enthusiasm	Level of effort
Degree of difficulty	Easy grade
Perceived value of topics	Access & convenience

Section III: KNOWLEDGE

14. Considering your present knowledge of personal finance, how would you rate your ability to:	Very high	High	Medium	Low
i) explain common terms and basic concepts in personal finance?				
ii) articulate issues concerning the management of your money?				
iii) critique popular publications on personal financial issues?				
iv) critique views expressed in the media (radio and television) on personal financial issues?				
v) identify priorities relating to your personal financial plan?				
vi) make personal financial decisions?				

Section IV: TOOL USE

LEARNING TOOLS
1. Print Material
2. Videos
3. Online information
4. Communication software
5. Online Interactive Practice Tests

15. From the list above, select in order of your preference, three tools that you enjoyed using the most

    Most enjoyable

    Next

    Next

16. From the list above, select in order of your preference, three tools that you least enjoyed using

    Least enjoyable

    Next

    Next

17. From the list above, select **three tools** that you used **most frequently.**

    Most frequent

    Next

    Next

18. From the list above, select **three tools** that you used **least frequently.**

    Least frequent

    Next

    Next

LEARNING TOOLS

1. Print Material
2. Videos
3. Online information
4. Communication software
5. Online Interactive Practice Tests

19. From the list above, select **three tools** that helped you prepare the most for Tests

Most helpful

Next

Next

20. From the list above, select **three tools** that helped you critiquing an article

Most helpful

Next

Next

21. From the list above, select **three tools** that helped you the most in writing discussion comments

Most helpful

Next

Next

22. From the list above, select **three tools** that helped you the most in finding Articles/Websites

Most helpful

Next

Next

THANK YOU VERY MUCH FOR PARTICIPATING!

Appendix E

Proficiency with Online Tools

Personal Finance 499(f) **PROFICIENCY WITH ONLINE TOOLS**

This short questionnaire is part of continuing research associated with the introduction of personal finance on the web. It should take a few minutes to complete. Your candid responses will help us better understand your proficiency with online tools and to help us improve various aspects of the course. Thank you for participating.

1. Have you ever taken an online or web-based course? **Yes** **No**
   (If no, please go to question 3)

2. Briefly describe this course(s) ____

3. Do you have access to the web via an internet provider?

4. Do you have access to the web via dialup?

5. <u>**BEFORE**</u> **taking this course (Back in September),**
   how would you classify your skill level with respect to: **Very high** **High** **Medium** **Low** **None**

   a) using a computer?

   b) using A spreadsheet or database program?

   c) searching for information on the internet/www?

   d) using descriptors for searches or boolean commands?

   e) downloading files or software from the internet?

   f) creating or editing a web site?

   g) participating in mailing lists (listserves)?

   h) using communication software (eg. FirstClass)

   i) using email?

   j) sending and receiving files electronically?

   k) using a chat feature?

   l) watching videos on the internet?

6. How would you rate your overall proficiency using online tools?

7. So far, approximately how many hours have you spent on learning to use online tools applicable to this course (eg. like FirstClass)? ___________ hours

Appendix F

Summative Course Evaluation

Summative Course Evaluation

Personal Finance 499(f) **Summative Course Evaluation** Fall 1999

Please click on the circle next to the words which best describe your reactions.

THE WEB SITE

1. Is easy to navigate.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
2. Is rich in content.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
3. Provides many opportunities to learn.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
4. Accommodates the way I like/prefer to learn.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
5. Overall, it is well designed.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly

THE LEARNING TOOLS

6. The textbook is a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
7. The Concordia videos are a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
8. The CBC videos are a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
9. The chapter websites are a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
10. The axioms are a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
11. FirstClass is a valuable learning resource.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
12. There are sufficient tools to promote interaction with course material.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
13. Overall, the tools helped me to learn about personal finance.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly

THE INSTRUCTOR

14. Makes the student feel welcome in seeking help.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
15. Provided useful information on a timely basis.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
16. Created an atmosphere of encouragement and support.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
17. Created an atmosphere to encourage student participation.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
18. Provided grades on a timely basis.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
19. Is accessible.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
20. Overall, the instructor performed effectively.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly

THE COURSE

21. The course outline is clear and complete (e.g., learning objectives, course topics, evaluation method).	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
22. The methods used for evaluating student work are fair.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
23. The subject matter of this course is something that I consider useful.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
24. There is sufficient help available to resolve technical issues.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
25. Overall, I have learned a great deal in this course.	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly

COMMENTS: Please provide any comments you would like to add about this course or your instructor.

Submit

Appendix G

Recurring Online Questions

Recurring Online Questions

These questions appear under "Review Exercises" (online) and students are expected to answer these before they attempt content-based questions for each of the 14 chapters

Please answer the following questions before doing the exercises

Enter Student ID: Do not hit the "enter" key

1. **Read chapter:** yes no

2. **Made personalized chapter notes:** yes no

3. **Watched video**

   CBC Chapter video Did not watch

4. **Read the following for the chapter**

   Axioms Facts of Life Stop & Think

5. **Attempted mini-cases** yes no

6. **Posted a discussion comment related to the chapter**

   yes no

7. **Took chapter pretest:** yes no

8. **Took chapter posttest** yes no

9. **Familiarity with chapter**

   a) before attempting any of the above

   high medium low

   b) After attempting some (or all) of the above

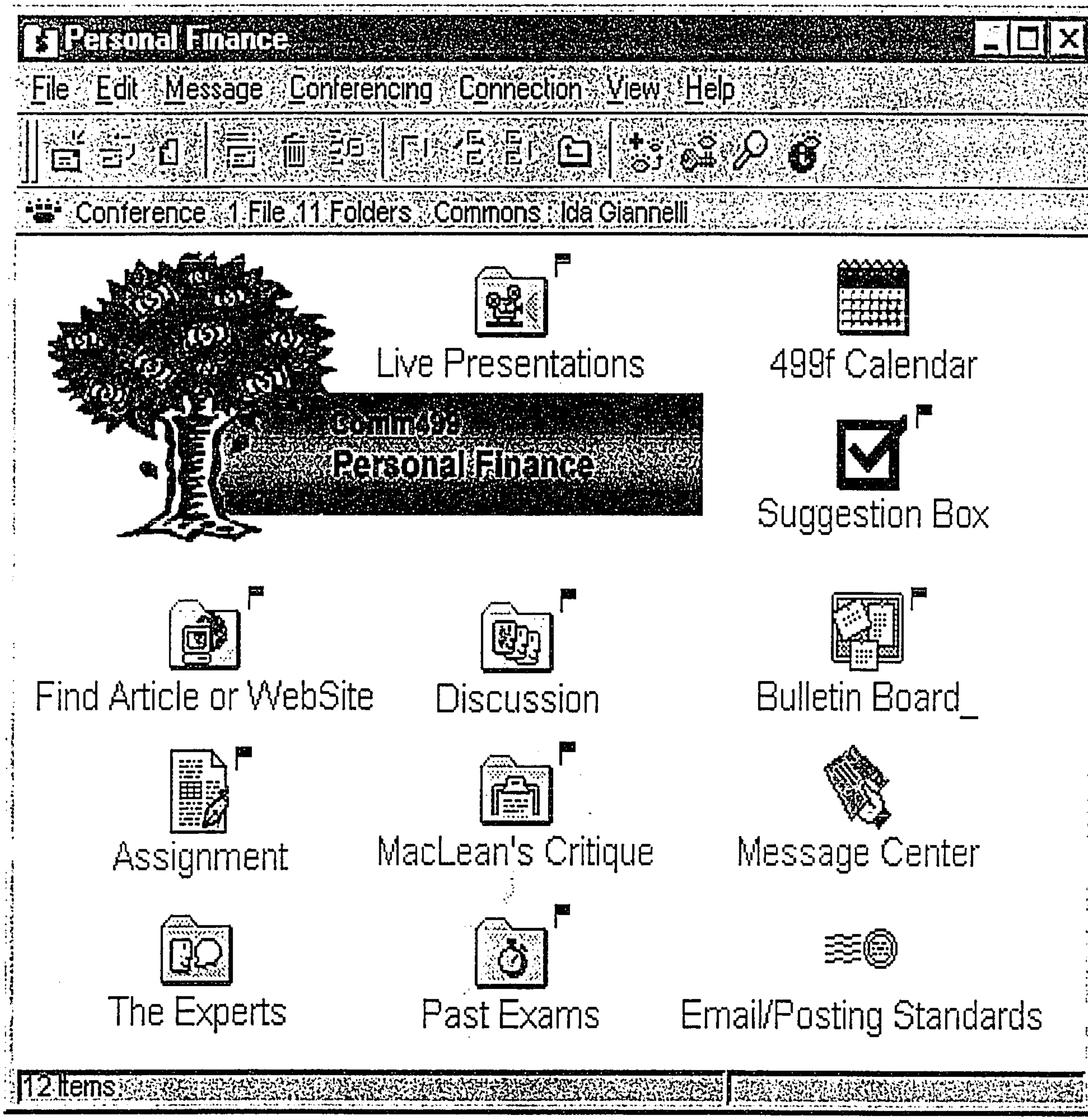
   high medium low

Go to Questions

Appendix H

FirstClass Interface

First Class Interface



Appendix I

Course Outline

;*c1P

Concordia
UNIVERSITY

Faculty of Commerce & Administration

Personal Finance 499f

Instructor:	Arshad Ahmad
Special Topics in Commerce:	Personal Finance 499f
Contact Info:	GM 503-47 ; (514) 848-2928 *email:* arshad@vax2.concordia.ca
Office hours:	Wednesday 12:00 - 2:00, or by appointment in office or virtually

Required Text(s) & Software: (Available in the Downtown Bookstore)

- Brown, Chambers & Currie (1999), Personal Finance for Canadians, Prentice-Hall Canada. This text comes with: Stull, A.T. (1997). Surfing for success in business & economics: A student's guide to the internet, Canadian edition. Prentice-Hall Canada.

- The MacLean's Guide to Personal Finance: (1999)

- Video Series & FirstClass Software on CD-Rom

- Neysmith, B., & Rabiasz, M. (1995). CBRS's guide to Fixed-Income Investing. Canadian Bond Rating Service. Distributed during orientation free of charge.

References:

- Keown, A.J. (1998). Personal Finance: Turning money into wealth. Prentice-Hall, New Jersey.

- Redja, G.E. & McNamara, M.J. (1998). Personal Financial Planning. Addison Wesley.

- Kapoor, J.R., Dlabay, L.R., & Hughes, R.J. (1999). Personal Finance. Irwin, McGraw-Hill.

- Kwok, H., & Robinson, C. (1999). Personal Financial Planning. 2nd edition. Captures Press Inc.

Minimum computer requirements:

- A 640 x 480, 256-color monitor (recommended: 800 x 600)
- PC requirements: 8 MB RAM with windows 3.1 (5 MB available); or 16 MB for Pentium with Windows 95/NT (10 MB available)
- A modem or connection with a network & a Web browser (eg. Netscape 3.0 or above)
- Mac requirements: 68040 33 MHz, 8MB RAM (5 MB available) with System 7.1 or higher; or PowerPC, 16 RAM MB (8 MB available) with system 7.5 or higher.

Help Desk: You are encouraged to download FirstClass software (free of charge) by accessing the following online helpdesk: http://www-commerce.concordia.ca/helpdesk. Technical support for other queries should be addressed to: comm499support@mercato.concordia.ca, or call (514) 848-4286. In-person Tech support is available on Wed, Thu & Fri (5:30 7:30) & Sun (10:00 2:00) at GM 503-56.

Course Format: There will be no classroom lectures, however, you must attend the orientation meeting on Friday, September 10, in H-110 between 8:45 and 11:00. The purpose of the first meeting is to familiarize you with the organization of the course, form groups, issue passwords, etc.

Learning Outcomes: This course has been designed to accomplish multiple cognitive and affective objectives, which are explained below. A detailed breakdown of specific learning objectives related to each lesson is presented online. Tasks have been designed to encourage you to think critically about personal financial issues. Accordingly, some of the tasks focus on individual work. In addition, many other activities have been structured to develop co-operative and collaborative skills. The purpose of these activities is to create a social environment for a community of learners and practionners. Furthermore, these skills will help you take advantage of peer expertise and feedback and produce learning synergies that would not be possible in a traditional classroom format. At the end of this course, you should be able to:

→ Understand the terminology and basic concepts underlying personal financial management.

→ Speak the language used in making personal financial decisions.

→ Research valid sources of information that enable individuals to make sound personal financial decisions.

→ Evaluate media reports and popular publications on personal financial management.

→ Articulate how your views relate to some fundamental issues in personal finance and develop these into action plans where applicable.

→ Analyze and problem-solve basic questions as well as simple cases that involve multiple concepts in personal finance.

→ Work collaboratively with your peers in developing expertise in at least one area in personal finance.

→ Plan, organize, and apply some personal financial decisions to your own situation or seek advice from professionals where appropriate.

Summary:

Personal finance 449f is not about "hot tips" or discovering money-making machines! Instead, it is about getting informed to learn how you can better manage your current and future financial affairs. This course has been designed with a sequence of learning material and activities that will lay the foundation for understanding deeper issues and developing expertise. In addition, the learning environment also encourages you to discover and regulate at your own pace the acquisition of knowledge from multiple sources of information.

Instructional Tools: Learning activities have been organized to take advantage of 4 types of instructional tools:

1. **Textbook & Supplements.** These are in printed form and comprise the minimum learning material that you are responsible for. They are also the basis for several assessment activities explained below.

2. **Video series.** Each learning module has i) "Concordia Voices" - a series of short videos introducing you to the topics covered, and ii) CBC video series that demonstrates personal finance in action. These videos showcase important personalities and events in the world of personal finance and should help to expand your knowledge for each of the topics in the course. They also provide concepts and authentic applications that are the basis for online discussion.

3. **Pre/Post Tests,Review Exercises & other learning aids.** To assess how much you already know, to monitor your progress in understanding chapter material, and level of mastery after learning each topic, several online learning tools are available on the course website. These include:
   - The Pre-Test: Provides a benchmark for what you already know.
   - Review Exercises with suggested solutions: Selected end of chapter questions
   - Mini-cases: Short questions follow a brief scenario on various topics
   - Websites: Provides links to a wealth of information related to topics in each chapter
   - The Post Test: Allows you to assess what you have learned.

   All of these online tools have pop-up solutions and convenient reports on your performance. In addition each chapter has begins with the main learning objectives, an introductory video and the following chapter applications: "Facts of Life", "Stop & Think", "Axioms" and a "Glossary".

4. **FirstClass Communication Software**. This software is to be used for communication activities including e-mail, threaded discussion, posting information, and providing feedback to peers. Also see the following online helpdesk: http://www-commerce.concordia.ca/helpdesk.

Grades

Summary of work that will be graded: You are required to search for one article or website, critique an assigned article, participate in a discussion, select a short assignment, and write 2 short tests. Each of these activities is elaborated below:

		Weight %
Virtual attendance		5
Find an article or website (individual)		10
Article critique (5 per group)		
Feedback	8	
Final Report	12	20
Online Quiz		15
Discussion comments (individual) OR		
Story (individual)		10
Assignment (individual)		10
Final Exam* (in Hall 110)		25
Bonus (individual)		10
Total grade		105

*A minimum grade of 40% on the final exam is required to pass the course.

Grade Conversion Table:

A+	90 >
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
C+	67-69
C	63-66
C-	60-62
D+	57-59
D	53-56
D-	50-52
F or FNS	49 <

Virtual Attendance (5)

You are expected to spend at least 2 hours logged on during any given week. By spending at least 2 hours a week you automatically earn full marks for attendance.

For our system to track and record the time and frequency of your visits to the website, you must begin your session by clicking on the "**Start Session**" button which is located on the home page. When you are ready to log off click on the "**End Session**" button. Do not log-on by activating bookmarks and do not log-off by clicking on the close window button (the little "x" on the top side) of your browser.

Make it a habit to click the "Start Session" button when you connect and "End Session" button when you disconnect. This is very important because as mentioned, it is the only way for the system to track your attendance on the web. You earn $\frac{1}{2}$ mark for spending 2 hours spread over a week. September 11th marks the beginning of the first week.

Find an Article or Website (10)

To introduce you to basic research and keep you up to date about current issues in personal finance, your task is to find a recent (1998 or later) article or website on any topic in the course. The article should be short (a page or two) and should come from a popular, well-known source such as Fortune, The Financial Post, or Money Magazine, or from Canadian newspapers. If you decide to find a website, it must conform to quality standards similar to website examples posted online under each chapter.

Once you have selected the article or website, cite the title & complete source, and write a brief (maximum 2 paragraph) summary of what you have read. This summary should address the following:

i) What is the main point of the article/website as it relates to **specific concepts** in personal finance? Make sure you clearly identify these concepts.
ii) Why is the article/ website meaningful to you?
iii) Why should your peers read the article or visit the site - what do you think they are most likely to benefit from?

Your summaries are to be posted to the "Find-the-Article/or Website" folder in FirstClass by October 8th, midnight. This exercise will be graded as 10, 7, 4, or 1 marks.

Article Critique (12)

You will be assigned an article from The Maclean's Guide to Personal Finance (available from the Bookstore). Post a working copy or draft of your critique to the "Draft" folder in FirstClass by **October 15th**, midnight. For late postings, 1 mark will be deducted each day.

Begin your draft with the title and full citation followed by one summary paragraph that highlights the main points and context of the article. The remainder of your critique should contain your opinions, reactions and evaluation of the article. Do not repeat what has already been said. Your grade is based on **identifying concepts** (or the lack of them) in the article. Make sure you address the following:

i) Full names & ID numbers of each group member & title of the article.
ii) What parts of the article relate to specific **topics and concepts** in the course?
iii) What are the major strengths and weaknesses of the article? What is missing given the content and topic?
iv) How can it be improved?
v) Complete citations of references made to other articles.

The maximum length of your draft is 1 typed single-spaced page. It is strongly recommended that you read other articles on the subject area to enrich your critique. Include complete citations of references made to other articles or informational sources related to your topic.

Once you have received feedback from another group (**November 12th**, midnight), incorporate changes from the feedback report, refine your draft by revisiting the criteria for the article critique and post your final copy by **November 26th**, midnight to the "Final Copy" folder in FirstClass.

Feedback (8)

Each group will provide feedback to one other group. All feedback must be posted by **November 12th**, midnight, in the "Feedback Folder" in First Class. The purpose of this assignment is to provide constructive criticism to your peers that will help them to improve their draft. The maximum length is 1 typed page. Your feedback should address the following:

i) Full names & ID numbers of each group giving feedback & reference to the group receiving feedback.
ii) Identify **missing concepts** that are related to the topics covered in the article.
iii) Suggest three different ways to significantly improve the draft.
iv) Provide at least 2 references (cite the sources) that would add to the quality of the draft.

Online Quiz (15)

This will test your understanding of basic material learned from the following text chapters: 1, 2, 8, 10 & 11 as well as the corresponding video segments. You will not be tested on any supplementary readings, web-sites, Facts of Life or Stop & Think material. The format of the quiz will be similar to Pre/Post-tests, and review exercises. The test will include True/False, Multiple Choice and Short answer questions and will last for 1 hour. The test will be available online on **October 29th** from 9:00 am to 12:00 p.m. It is your responsibility to log-on, click on the Test-Yourself icon and set aside one hour to complete the test. After you finish the test, make sure you click the submit button! Note: This test cannot be retaken.

Discussion (3 x 3.33 = 10)

By reflecting on the readings and especially on video material (also see discussion questions under the CBC videos icon), or by reacting to current course-related news items, you are required to post THREE comments in the "Discussion" folder in First Class. To access this folder, click on the Discussion icon. Note, three sub-folders (labeled Comment #1, Reaction #2 and Comment #3) have been created within the discussion folder. **Post your discussion comments in the appropriate sub-folder.** Each comment is worth a maximum of 3.33 (3.33, 2, 1 or 0 marks will be assigned for each discussion comment). Comments should be brief - maximum length is one paragraph.

You are encouraged to reflect and show your thinking - avoid rewriting and repeating what you have read. Instead, interpret issues relevant to personal finance in **your own words** and make original contributions that **reflect your thinking**. Comments that integrate **concepts** from the course are especially encouraged.

The first comment (**due September 24th**, midnight) should be posted in the appropriate sub-folder (these represent course topics) under "Discussion - Comment #1". The second comment must respond to a comment made by your peers (**due October 22th**, midnight) and posted under "Discussion - Reaction #2". When you post Reaction #2, make sure you copy and paste the comment you are reacting to. The third comment (**due November 26th**, midnight) may be an original comment or another reaction to comments made earlier and posted under "Discussion - Comment #3".

OR

Story (10)

Summarize, in no more than a page, a story, event or experience that you have read about or encountered, that is related to any topic in the course. You could be reacting to a video segment, article read in the newspaper; a clip from television; you could be sharing a work-related experience; you could be philosophizing about beliefs that drive individuals in making personal financial decisions. The story should be short, related to the course and worth sharing with your peers. The story should not be a simple restatement of facts that you extracted from a news article, but rather your reaction and/or thoughts about some personal finance issue. Note, the main difference between discussion comments and the story is that the latter has to "stand on its own". This means it should have at least the following elements: (a) an introduction or context (b) content containing concepts related to the course and (c) an ending consisting of reflections or lessons learned. Depending on how carefully you follow these guidelines as well as on the quality of your submission, a grade of 10, 6, 4 or 1 will be assigned. Mail the story in the FirstClass "Story" Folder by **November 19th**, midnight.

Assignment (10)

The deadline for the assignment is **December 3rd**, midnight. Select ONE of the following:

1. Worksheet: Read the instructions provided in the "Wortsheet" folder. Your completed assignment must be posted in the "Worksheet" folder in First Class.

2. Internet Exercise:Read the instructions provided in the "Internet Exercise" folder.Your completed assignment must be posted in the "Internet Exercise" folder in First Class.

3. Minicase: Read the instructions provided in the "Mini-Case" folder.Your completed assignment must be posted in the "Minicase" folder in First Class.

NOTE: When you are ready to submit your assignment in the appropriate folder make sure (a) that your message is clearly labelled as "Assignment" and (b) the content of your assignment is either in the body of your message or included as an attachment.

Final Exam (25%)

The final exam will be held in December, H-110 (date and time to be announced). This will test your understanding of basic material learned from the following text chapters: 3, 5, 7, 12, 13, & 14 as well as the corresponding video segments. You will not be tested on any supplementary readings, web-sites, Facts of Life or Stop & Think material. The format of test questions will be similar to the Pre/Post-tests, Review Exercises and Test I. This exam will include True/False, Multiple Choice and Short answer questions and will last for 2 hours.

Bonus (10 marks)

As an incentive to practice on-line questions, you can earn up to 10 bonus marks for attempting 3 practice sets per chapter. Regardless of your score, by simply **attempting all questions** of the following: (i) Pre-test, (ii) Review Exercises, and (iii) Post Test you earn 1 mark per chapter up till a maximum of 10.

Pre & Post Tests mark the beginning and ending of learning activities for each chapter. Before you start learning about any chapter, begin by first attempting a chapter Pre-Test. Pre-Tests can be found by clicking on the "Test Yourself" icon on the left-hand side of your screen. Each Pre-Test consists of 10 questions (True/False & Multiple Choice) and should take you about 15 minutes to complete. Your score on the Pre-Test provides a rough indication of your basic knowledge about the chapter. After completing the test, click on the submit button and review your results. If you get a poor score on the Pre-Test, then spend more time on the particular chapter learning material. Note: Do not attempt the Post-Test right after taking the Pre-Test. Instead, learn as much as you can about the topic, attempt the review questions and then take the Post-Test.

Sequence

For each chapter, the following sequence of learning activities is strongly recommended:

Start with the online Pre-Test

Watch the chapter videos (Concordia Voices and CBC)

Browse the "Facts of Life", "Stop & Think" and "Axiom" icons

Read the Chapter from the Textbook

Browse the "Websites" icon

Practice online "Review Exercises" and "Minicases"

End with the online Post-Test

Summary of Tasks	Key Due Dates	Marks (Maximum)
Discussion Comment #1	September 24	3.33
Find An Article or Website	October 8	10
Draft Critique	October 15	-
Discussion Comment #2	October 22	3.33
Online Test	October 29	15
Feedback	November 12	8
Story*	November 19	10
Final Critique	November 26	12
Discussion Comment #3	November 26	3.33
Assignment	December 3	10
Final Exam	December (TBA)	25
Note:		
Attendance	2 hours per week	10
Bonus	Pre-Test, Review Exercises & Post-Test	10

Weekly Planner

Week	Chapter	Topic (Required Text)	To Do & Deadlines
1	In Hall-110 from 8:45 to 11:00 am **- Attend orientation!**		• Purchase course material from downtown bookstore • Review course outline • Sign Consent Form • Get familiar with support services • Account passwords/Visit web site • Form groups • Site Demo • Software Demo • Fill out Questionnaire • Question Period
2	1 4	Financial Planning Financial Security* 5x l-0o	
3	2	Personal Income Taxes	Post 1st discussion comment
4	8	Interest	Especially important to practice problem solving
5	9	Saving and Investment	Find an article or website
6	10	Debt Securities*	Post Draft of your Article Critique
7	11	Stocks*	Post 2nd discussion comment
8	11	Mutual Funds*	Test
9	12	Consumer Credit & Loans*	
10	13	Home Mortgages	Post Feedback on the Draft Article
11	14	Credit, Debt & Bankruptcy*	Post Story
12	5 6	General Insurance* Life Insurance	Post Assignment Post 3rd discussion comment
13	7 3	Retirement Income Wills	**Final Exam**

Note: Each topic has at least one introductory video (Concordia Voices). The topics with * indicate CBC videos

FirstClass Software (See Handout on First Class Software for complete details during Orientation)

Appendix J

Structural Equation Modeling - Program Output

1

```
EQS, A STRUCTURAL EQUATION PROGRAM          MULTIVARIATE SOFTWARE, INC.
COPYRIGHT BY P.M. BENTLER                   VERSION 5.7b (C) 1985 - 1998.

  PROGRAM CONTROL INFORMATION

/TITLE
essai1
/SPECIFICATIONS
 DATA='U:\FPONS\FRANK\FINANCE\DATA.ESS';
 VARIABLES= 23; CASES=  338;
 METHODS=ML;
 MATRIX=RAW;
/LABELS
V1=NOTES; V2=VIDEO; V3=CHAPTER; V4=AXIOMS; V5=FACTS;
V6=PRESCORE; V7=POSTSCOR; V8=PRENUM; V9=POSTNUM; V10=CRITIQUE;
V11=FEEDBACK; V12=ARTICLE; V13=MIDTERM; V14=ASSIGN; V15=FINALEXA;
V16=TIMETOT; V17=LOGINS; V18=COMMSTOR; V19=MINICASE; V20=VA;
V21=BONUS; V22=FACULTY; V23=PROFIC;
/EQUATIONS
V1 =  + 1F1  + E1;
V2 =  + *F1  + E2;
V3 =  + *F1  + E3;
V4 =  + *F1  + E4;
V5 =  + *F1  + E5;
V6 =  + 1F2  + E6;
V7 =  + *F2  + E7;
V8 =  + *F2  + E8;
V9 =  + *F2  + E9;
V10 =  + 1F3  + E10;
V11 =  + *F3  + E11;
V12 =  + *F3  + E12;
V13 =  + *F3  + E13;
V14 =  + *F3  + E14;
V15 =  + *F3  + E15;
F1 = *F5 + D1;
F2 = *F5 + D2;
F3 = 1F5 + D3;
F5 = *V16 + *V17 + *V23 + *V22+ D5 ;
/VARIANCES
D1 = *;
D2 = *;
D3 = *;
E1 = *;
E2 = *;
E3 = *;
E4 = *;
E5 = *;
E6 = *;
E7 = 1;
E8 = *;
E9 = *;
E10 = *;
E11 = *;
E12 = *;
E13 = *;
E14 = *;
E15 = *;
```

```
TITLE:   essai1
EQS/EM386 Licensee: Concordia University

/COVARIANCES
E5,E4 =*;
E8,E6=*;
E11,E10=*;
E12,E11=*;
E9,E8=*;

/LMTEST
 PROCESS=SIMULTANEOUS;
 SET=PVV,PFV,PFF,PEV,PEF,PEE,PDD,GVV,GVF,GFV,GFF,BVF,BFF;
/TECHNICAL
iteration = 90;
/END

   66 RECORDS OF INPUT MODEL FILE WERE READ


 DATA IS READ FROM U:\FPONS\FRANK\FINANCE\DATA.ESS
 THERE ARE  23 VARIABLES AND   338 CASES
 IT IS A RAW DATA ESS FILE
```

TITLE: essai1
EQS/EM386 Licensee: Concordia University

SAMPLE STATISTICS BASED ON COMPLETE CASES

UNIVARIATE STATISTICS

VARIABLE	NOTES	VIDEO	CHAPTER	AXIOMS	FACTS
MEAN	3.7041	8.6775	3.8846	6.6923	6.5503
SKEWNESS (G1)	0.5035	0.5007	0.5887	0.0454	0.1456
KURTOSIS (G2)	-0.6312	-0.3953	-0.4621	-1.3701	-1.4742
STANDARD DEV.	3.1171	6.8848	3.1437	4.9201	5.1969

VARIABLE	PRESCORE	POSTSCOR	PRENUM	POSTNUM	CRITIQUE
MEAN	64.0962	61.0751	14.9615	13.3935	9.7041
SKEWNESS (G1)	-1.5870	-1.5573	0.3629	0.2121	-1.9444
KURTOSIS (G2)	4.3610	2.3781	1.2624	0.6857	6.4561
STANDARD DEV.	17.7312	21.9346	7.2272	7.0984	2.1366

VARIABLE	FEEDBACK	ARTICLE	MIDTERM	ASSIGN	FINALEXA
MEAN	5.9148	6.9672	4.8848	5.9349	8.4608
SKEWNESS (G1)	-1.4360	-1.7609	-1.3813	-1.5867	-2.2426
KURTOSIS (G2)	3.9666	5.9163	2.0703	2.4865	5.6038
STANDARD DEV.	1.5601	1.6799	1.6336	2.1574	2.3990

VARIABLE	TIMETOT	LOGINS	FACULTY	PROFIC
MEAN	30.0192	60.9379	0.5296	1.8935
SKEWNESS (G1)	1.7934	1.9631	-0.1186	-0.1412
KURTOSIS (G2)	5.4756	6.4355	-1.9859	-1.3053
STANDARD DEV.	24.0331	42.7231	0.4999	1.4207

MULTIVARIATE KURTOSIS

MARDIA'S COEFFICIENT (G2,P) = 68.3143
NORMALIZED ESTIMATE = 22.2300

ELLIPTICAL THEORY KURTOSIS ESTIMATES

MARDIA-BASED KAPPA = 0.1712 MEAN SCALED UNIVARIATE KURTOSIS = 0.6925

MARDIA-BASED KAPPA IS USED IN COMPUTATION. KAPPA= 0.1712

CASE NUMBERS WITH LARGEST CONTRIBUTION TO NORMALIZED MULTIVARIATE KURTOSIS:

CASE NUMBER	60	262	295	306	332
ESTIMATE	1341.6385	769.4269	1043.8793	1114.0912	717.0880

TITLE: essail
EQS/EM386 Licensee: Concordia University
COVARIANCE MATRIX TO BE ANALYZED: 19 VARIABLES (SELECTED FROM 23 VARIABLES)
BASED ON 338 CASES.

		NOTES V 1	VIDEO V 2	CHAPTER V 3	AXIOMS V 4	FACTS V 5
NOTES	V 1	9.716				
VIDEO	V 2	18.403	47.400			
CHAPTER	V 3	7.862	19.010	9.883		
AXIOMS	V 4	12.855	29.176	12.751	24.208	
FACTS	V 5	13.226	29.490	12.808	24.277	27.008
PRESCORE	V 6	9.743	26.994	9.211	18.551	17.609
POSTSCOR	V 7	17.346	47.283	18.470	36.060	33.650
PRENUM	V 8	8.383	19.771	9.108	14.899	15.259
POSTNUM	V 9	9.879	22.590	10.476	16.267	16.510
CRITIQUE	V 10	1.215	3.842	1.515	2.597	2.496
FEEDBACK	V 11	0.854	2.180	0.852	1.588	1.480
ARTICLE	V 12	0.979	2.178	0.865	1.717	1.817
MIDTERM	V 13	1.581	3.473	1.386	2.277	2.320
ASSIGN	V 14	2.328	5.267	2.283	3.799	3.873
FINALEXA	V 15	2.887	6.697	2.749	5.023	5.001
TIMETOT	V 16	24.868	58.735	25.181	45.620	42.618
LOGINS	V 17	44.038	107.570	43.717	83.518	86.144
FACULTY	V 22	-0.148	-0.167	-0.034	-0.110	-0.079
PROFIC	V 23	0.900	2.381	0.908	1.715	1.590

		PRESCORE V 6	POSTSCOR V 7	PRENUM V 8	POSTNUM V 9	CRITIQUE V 10
PRESCORE	V 6	314.394				
POSTSCOR	V 7	266.256	481.125			
PRENUM	V 8	72.902	93.370	52.233		
POSTNUM	V 9	59.969	90.775	44.781	50.388	
CRITIQUE	V 10	11.981	15.678	4.511	4.345	4.565
FEEDBACK	V 11	8.092	11.761	2.319	2.790	1.593
ARTICLE	V 12	5.496	9.679	3.289	3.322	1.388
MIDTERM	V 13	6.871	12.650	3.306	3.699	1.193
ASSIGN	V 14	6.788	14.865	4.555	5.619	1.720
FINALEXA	V 15	17.815	28.074	7.776	8.581	2.306
TIMETOT	V 16	89.674	156.710	58.801	57.203	7.640
LOGINS	V 17	198.447	305.475	136.277	125.455	17.581
FACULTY	V 22	-0.396	1.041	0.196	-0.402	-0.059
PROFIC	V 23	5.283	11.504	2.328	2.808	0.301

		FEEDBACK V 11	ARTICLE V 12	MIDTERM V 13	ASSIGN V 14	FINALEXA V 15
FEEDBACK	V 11	2.434				
ARTICLE	V 12	1.026	2.822			
MIDTERM	V 13	0.849	0.751	2.669		
ASSIGN	V 14	0.798	0.936	1.608	4.655	
FINALEXA	V 15	1.311	1.831	1.999	3.139	5.755
TIMETOT	V 16	3.355	7.028	7.906	10.835	17.897
LOGINS	V 17	14.252	17.483	13.222	23.723	36.705
FACULTY	V 22	-0.150	-0.094	-0.094	-0.043	-0.165
PROFIC	V 23	0.358	0.383	0.719	0.750	0.915

		TIMETOT V 16	LOGINS V 17	FACULTY V 22	PROFIC V 23
TIMETOT	V 16	577.588			
LOGINS	V 17	563.415	1825.263		
FACULTY	V 22	1.057	1.348	0.250	
PROFIC	V 23	10.719	19.142	0.021	2.018

```
BENTLER-WEEKS STRUCTURAL REPRESENTATION:

      NUMBER OF DEPENDENT VARIABLES = 19
          DEPENDENT V'S :      1    2    3    4    5    6    7    8    9   10
          DEPENDENT V'S :     11   12   13   14   15
          DEPENDENT F'S :      1    2    3    5

      NUMBER OF INDEPENDENT VARIABLES = 23
          INDEPENDENT V'S :     16   17   22   23
          INDEPENDENT E'S :      1    2    3    4    5    6    7    8    9   10
          INDEPENDENT E'S :     11   12   13   14   15
          INDEPENDENT D'S :      1    2    3    5

      NUMBER OF FREE PARAMETERS =  45
      NUMBER OF FIXED NONZERO PARAMETERS =  24


3RD STAGE OF COMPUTATION REQUIRED     18306 WORDS OF MEMORY.
PROGRAM ALLOCATED    190000 WORDS

DETERMINANT OF INPUT MATRIX IS   0.19016E+19
```

TITLE: essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

IN ITERATION # 1, MATRIX W_CFUNCT MAY BE SINGULAR. TOLERANCE = 0.100000E-11
YOU HAVE BAD START VALUES TO BEGIN WITH.
IF ABOVE MESSAGE APPEARS ON EVERY ITERATION, PLEASE PROVIDE BETTER START VALUES AND RE-RUN TH

IN ITERATION # 1, MATRIX W_CFUNCT MAY BE SINGULAR. TOLERANCE = 0.100000E-11
YOU HAVE BAD START VALUES TO BEGIN WITH.
IF ABOVE MESSAGE APPEARS ON EVERY ITERATION, PLEASE PROVIDE BETTER START VALUES AND RE-RUN TH

PARAMETER ESTIMATES APPEAR IN ORDER,
NO SPECIAL PROBLEMS WERE ENCOUNTERED DURING OPTIMIZATION.

RESIDUAL COVARIANCE MATRIX (S-SIGMA) :

		NOTES V 1	VIDEO V 2	CHAPTER V 3	AXIOMS V 4	FACTS V 5
NOTES	V 1	0.423				
VIDEO	V 2	0.959	2.323			
CHAPTER	V 3	0.283	1.242	0.439		
AXIOMS	V 4	0.957	1.281	0.631	1.081	
FACTS	V 5	1.177	1.242	0.536	1.095	1.108
PRESCORE	V 6	-1.461	0.727	-2.201	0.635	-0.532
POSTSCOR	V 7	-2.851	-0.069	-2.103	3.762	0.945
PRENUM	V 8	4.452	10.554	5.104	8.612	8.893
POSTNUM	V 9	6.056	13.627	6.582	10.153	10.319
CRITIQUE	V 10	-0.144	0.657	0.131	0.425	0.296
FEEDBACK	V 11	0.053	0.302	0.036	0.307	0.183
ARTICLE	V 12	-0.013	-0.149	-0.146	0.130	0.210
MIDTERM	V 13	0.405	0.717	0.188	0.397	0.416
ASSIGN	V 14	0.602	1.221	0.526	1.040	1.079
FINALEXA	V 15	0.410	0.889	0.226	1.062	0.990
TIMETOT	V 16	16.622	39.402	16.782	32.434	29.265
LOGINS	V 17	21.599	54.964	20.861	47.636	49.810
FACULTY	V 22	-0.048	0.069	0.069	0.051	0.084
PROFIC	V 23	0.235	0.821	0.230	0.651	0.513

		PRESCORE V 6	POSTSCOR V 7	PRENUM V 8	POSTNUM V 9	CRITIQUE V 10
PRESCORE	V 6	9.817				
POSTSCOR	V 7	17.624	31.905			
PRENUM	V 8	11.023	6.123	2.435		
POSTNUM	V 9	12.905	5.932	1.949	1.143	
CRITIQUE	V 10	5.433	3.875	2.213	2.111	0.144
FEEDBACK	V 11	4.233	4.804	0.965	1.473	0.157
ARTICLE	V 12	0.714	1.058	1.610	1.690	0.528
MIDTERM	V 13	1.205	2.436	1.318	1.765	0.174
ASSIGN	V 14	-1.527	-0.126	1.637	2.782	0.224
FINALEXA	V 15	5.878	6.554	3.587	4.507	0.159
TIMETOT	V 16	49.935	85.070	44.856	43.642	2.821
LOGINS	V 17	90.313	110.538	98.332	88.555	4.468
FACULTY	V 22	0.088	1.915	0.365	-0.237	-0.001
PROFIC	V 23	2.077	5.725	1.203	1.714	-0.088

		FEEDBACK V 11	ARTICLE V 12	MIDTERM V 13	ASSIGN V 14	FINALEXA V 15
FEEDBACK	V 11	0.083				
ARTICLE	V 12	0.159	0.077			
MIDTERM	V 13	0.249	0.007	0.108		
ASSIGN	V 14	-0.084	-0.156	0.314	0.233	

FINALEXA	V 15	0.046	0.262	0.141	0.412	0.480
TIMETOT	V 16	0.515	3.508	3.736	4.715	9.111
LOGINS	V 17	6.522	7.905	1.875	7.069	12.797
FACULTY	V 22	-0.115	-0.051	-0.044	0.032	-0.058
PROFIC	V 23	0.129	0.099	0.382	0.256	0.206

		TIMETOT V 16	LOGINS V 17	FACULTY V 22	PROFIC V 23
TIMETOT	V 16	0.000			
LOGINS	V 17	563.415	0.000		
FACULTY	V 22	1.057	1.348	0.000	
PROFIC	V 23	10.719	19.142	0.021	0.000

AVERAGE ABSOLUTE COVARIANCE RESIDUALS = 10.0802
AVERAGE OFF-DIAGONAL ABSOLUTE COVARIANCE RESIDUALS = 10.8973

TITLE: essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

STANDARDIZED RESIDUAL MATRIX:

		NOTES V 1	VIDEO V 2	CHAPTER V 3	AXIOMS V 4	FACTS V 5
NOTES	V 1	0.044				
VIDEO	V 2	0.045	0.049			
CHAPTER	V 3	0.029	0.057	0.044		
AXIOMS	V 4	0.062	0.038	0.041	0.045	
FACTS	V 5	0.073	0.035	0.033	0.043	0.041
PRESCORE	V 6	-0.026	0.006	-0.039	0.007	-0.006
POSTSCOR	V 7	-0.042	0.000	-0.030	0.035	0.008
PRENUM	V 8	0.198	0.212	0.225	0.242	0.237
POSTNUM	V 9	0.274	0.279	0.295	0.291	0.280
CRITIQUE	V 10	-0.022	0.045	0.019	0.040	0.027
FEEDBACK	V 11	0.011	0.028	0.007	0.040	0.023
ARTICLE	V 12	-0.003	-0.013	-0.028	0.016	0.024
MIDTERM	V 13	0.080	0.064	0.037	0.049	0.049
ASSIGN	V 14	0.090	0.082	0.078	0.098	0.096
FINALEXA	V 15	0.055	0.054	0.030	0.090	0.079
TIMETOT	V 16	0.222	0.238	0.222	0.274	0.234
LOGINS	V 17	0.162	0.187	0.155	0.227	0.224
FACULTY	V 22	-0.031	0.020	0.044	0.021	0.032
PROFIC	V 23	0.053	0.084	0.051	0.093	0.069

		PRESCORE V 6	POSTSCOR V 7	PRENUM V 8	POSTNUM V 9	CRITIQUE V 10
PRESCORE	V 6	0.031				
POSTSCOR	V 7	0.045	0.066			
PRENUM	V 8	0.086	0.039	0.047		
POSTNUM	V 9	0.103	0.038	0.038	0.023	
CRITIQUE	V 10	0.143	0.083	0.143	0.139	0.032
FEEDBACK	V 11	0.153	0.140	0.086	0.133	0.047
ARTICLE	V 12	0.024	0.029	0.133	0.142	0.147
MIDTERM	V 13	0.042	0.068	0.112	0.152	0.050
ASSIGN	V 14	-0.040	-0.003	0.105	0.182	0.049
FINALEXA	V 15	0.138	0.125	0.207	0.265	0.031
TIMETOT	V 16	0.117	0.161	0.258	0.256	0.055
LOGINS	V 17	0.119	0.118	0.318	0.292	0.049
FACULTY	V 22	0.010	0.175	0.101	-0.067	-0.001
PROFIC	V 23	0.082	0.184	0.117	0.170	-0.029

		FEEDBACK V 11	ARTICLE V 12	MIDTERM V 13	ASSIGN V 14	FINALEXA V 15
FEEDBACK	V 11	0.034				
ARTICLE	V 12	0.061	0.027			
MIDTERM	V 13	0.098	0.002	0.041		
ASSIGN	V 14	-0.025	-0.043	0.089	0.050	
FINALEXA	V 15	0.012	0.065	0.036	0.080	0.083
TIMETOT	V 16	0.014	0.087	0.095	0.091	0.158
LOGINS	V 17	0.098	0.110	0.027	0.077	0.125
FACULTY	V 22	-0.148	-0.060	-0.053	0.030	-0.048
PROFIC	V 23	0.058	0.041	0.165	0.084	0.061

		TIMETOT V 16	LOGINS V 17	FACULTY V 22	PROFIC V 23
TIMETOT	V 16	0.000			
LOGINS	V 17	0.549	0.000		

FACULTY	V 22	0.088	0.063	0.000	
PROFIC	V 23	0.314	0.315	0.030	0.000

AVERAGE ABSOLUTE STANDARDIZED RESIDUALS = 0.0921
AVERAGE OFF-DIAGONAL ABSOLUTE STANDARDIZED RESIDUALS = 0.0985

LARGEST STANDARDIZED RESIDUALS:

V 17,V 16	V 17,V 8	V 23,V 17	V 23,V 16	V 9,V 3
0.549	0.318	0.315	0.314	0.295
V 17,V 9	V 9,V 4	V 9,V 5	V 9,V 2	V 16,V 4
0.292	0.291	0.280	0.279	0.274
V 9,V 1	V 15,V 9	V 16,V 8	V 16,V 9	V 8,V 4
0.274	0.265	0.258	0.256	0.242
V 16,V 2	V 8,V 5	V 16,V 5	V 17,V 4	V 8,V 3
0.238	0.237	0.234	0.227	0.225

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MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

DISTRIBUTION OF STANDARDIZED RESIDUALS

```
   ----------------------------------------
   !                                       !
120-                                       -
   !                                       !
   !                     *                 !
   !                     *                 !
   !                     *                 !
 90-                     *                 -
   !                     *                 !
   !                     *                 !
   !                     *                 !
   !                     *                 !
 60-                     *                 -
   !                     *                 !
   !                     *                 !
   !                     *                 !
   !                     *  *              !
 30-                     *  *              -
   !                  *  *  *  *           !
   !                  *  *  *  *           !
   !                  *  *  *  *           !
   !                  *  *  *  *  *        !
   ----------------------------------------
      1  2  3  4  5  6  7  8  9  A  B  C
```

	RANGE			FREQ	PERCENT
1	-0.5	-	--	0	0.00%
2	-0.4	-	-0.5	0	0.00%
3	-0.3	-	-0.4	0	0.00%
4	-0.2	-	-0.3	0	0.00%
5	-0.1	-	-0.2	1	0.53%
6	0.0	-	-0.1	25	13.16%
7	0.1	-	0.0	106	55.79%
8	0.2	-	0.1	33	17.37%
9	0.3	-	0.2	21	11.05%
A	0.4	-	0.3	3	1.58%
B	0.5	-	0.4	0	0.00%
C	++	-	0.5	1	0.53%
	TOTAL			190	100.00%

EACH "*" REPRESENTS 6 RESIDUALS

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MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

GOODNESS OF FIT SUMMARY

INDEPENDENCE MODEL CHI-SQUARE = 4555.446 ON 171 DEGREES OF FREEDOM

INDEPENDENCE AIC = 4213.44620 INDEPENDENCE CAIC = 3388.70535
MODEL AIC = 269.19743 MODEL CAIC = -430.14423

CHI-SQUARE = 559.197 BASED ON 145 DEGREES OF FREEDOM
PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS LESS THAN 0.001
THE NORMAL THEORY RLS CHI-SQUARE FOR THIS ML SOLUTION IS 557.343.

BENTLER-BONETT NORMED FIT INDEX= 0.877
BENTLER-BONETT NONNORMED FIT INDEX= 0.889
COMPARATIVE FIT INDEX (CFI) = 0.906

ITERATIVE SUMMARY

ITERATION	PARAMETER ABS CHANGE	ALPHA	FUNCTION
1	98.379906	0.50000	23.45942
2	58.716587	1.00000	11.01572
3	16.057735	1.00000	7.99117
4	10.152291	1.00000	5.78627
5	3.664379	1.00000	5.65876
6	0.648750	1.00000	4.39662
7	1.039649	0.50000	3.45117
8	0.412601	1.00000	2.39818
9	0.496202	1.00000	1.94404
10	0.833292	1.00000	1.67730
11	0.185403	1.00000	1.66589
12	0.119736	1.00000	1.66492
13	0.130330	0.50000	1.65937
14	0.002473	1.00000	1.65934
15	0.002049	1.00000	1.65934
16	0.001466	1.00000	1.65934
17	0.001673	0.50000	1.65934
18	0.000021	1.00000	1.65934

```
TITLE:   essai1
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MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

MEASUREMENT EQUATIONS WITH STANDARD ERRORS AND TEST STATISTICS


NOTES    =V1  =     1.000 F1    +   1.000 E1



VIDEO    =V2  =     2.344*F1    +   1.000 E2
                     .079
                   29.539

CHAPTER =V3   =     1.019*F1    +   1.000 E3
                     .039
                   25.846

AXIOMS   =V4  =     1.599*F1    +   1.000 E4
                     .061
                   26.056

FACTS    =V5  =     1.619*F1    +   1.000 E5
                     .069
                   23.419

PRESCORE=V6   =     1.000 F2    +   1.000 E6



POSTSCOR=V7   =     1.803*F2    +   1.000 E7
                     .108
                   16.666

PRENUM   =V8  =      .351*F2    +   1.000 E8
                     .031
                   11.408

POSTNUM =V9   =      .341*F2    +   1.000 E9
                     .034
                   10.133

CRITIQUE=V10 =      1.000 F3    +   1.000 E10



FEEDBACK=V11 =       .589*F3    +   1.000 E11
                     .082
                    7.217

ARTICLE =V12 =       .730*F3    +   1.000 E12
                     .108
                    6.752


MEASUREMENT EQUATIONS WITH STANDARD ERRORS AND TEST STATISTICS (CONTINUED)
```

```
TITLE:   essail
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

VARIANCES OF INDEPENDENT VARIABLES (CONTINUED)
----------------------------------------------

E13 -MIDTERM                 1.679*I                                 I
                              .144 I                                 I
                            11.668 I                                 I
                                   I                                 I
E14 -ASSIGN                  2.522*I                                 I
                              .228 I                                 I
                            11.043 I                                 I
                                   I                                 I
E15 -FINALEXA                1.361*I                                 I
                              .227 I                                 I
                             5.984 I                                 I
                                   I                                 I
```

TITLE: essail
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

CONSTRUCT EQUATIONS WITH STANDARD ERRORS AND TEST STATISTICS

```
F1   =F1  =     1.711*F5    +   1.000 D1
                 .285
                6.011

F2   =F2  =     8.246*F5    +   1.000 D2
                1.387
                5.945

F3   =F3  =     1.000 F5    +   1.000 D3


F5   =F5  =      .008*V16   +    .007*V17   -    .235*V22   +    .193*V23
                 .002            .001            .107            .042
                3.554           4.962          -2.194           4.563

           +    1.000 D5
```

```
TITLE:   essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

VARIANCES OF INDEPENDENT VARIABLES
----------------------------------

                     V                                F
                    ---                              ---
V16 -TIMETOT               577.588*I                                I
                            44.496 I                                I
                            12.981 I                                I
                                   I                                I
V17 -LOGINS               1825.263*I                                I
                           140.613 I                                I
                            12.981 I                                I
                                   I                                I
V22 -FACULTY                  .250*I                                I
                              .019 I                                I
                            12.981 I                                I
                                   I                                I
V23 -PROFIC                  2.018*I                                I
                              .155 I                                I
                            12.981 I                                I
                                   I                                I
```

```
TITLE:   essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

VARIANCES OF INDEPENDENT VARIABLES
----------------------------------

                  E                                  D
                 ---                                ---
E1  -NOTES                  1.853*I D1   -    F1                5.116*I
                             .175 I                              .567 I
                           10.605 I                             9.016 I
                                  I                                   I
E2  -VIDEO                  4.179*I D2   -    F2               83.928*I
                             .580 I                            13.364 I
                            7.209 I                             6.280 I
                                  I                                   I
E3  -CHAPTER                1.724*I D3   -    F3                 .384*I
                             .167 I                              .121 I
                           10.311 I                             3.173 I
                                  I                                   I
E4  -AXIOMS                 4.100*I D5   -    F5                 .571*I
                             .402 I                              .150 I
                           10.202 I                             3.799 I
                                  I                                   I
E5  -FACTS                  6.390*I                                   I
                             .578 I                                   I
                           11.048 I                                   I
                                  I                                   I
E6  -PRESCORE             166.658*I                                   I
                           12.862 I                                   I
                           12.957 I                                   I
                                  I                                   I
E7  -POSTSCOR               1.000 I                                   I
                                  I                                   I
                                  I                                   I
                                  I                                   I
E8  -PRENUM                32.815*I                                   I
                            2.476 I                                   I
                           13.253 I                                   I
                                  I                                   I
E9  -POSTNUM               33.185*I                                   I
                            2.559 I                                   I
                           12.967 I                                   I
                                  I                                   I
E10 -CRITIQUE               3.243*I                                   I
                             .268 I                                   I
                           12.084 I                                   I
                                  I                                   I
E11 -FEEDBACK               1.942*I                                   I
                             .155 I                                   I
                           12.492 I                                   I
                                  I                                   I
E12 -ARTICLE                2.117*I                                   I
                             .173 I                                   I
                           12.254 I                                   I
                                  I                                   I
```

```
TITLE:   essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

MIDTERM =V13 =       .865*F3    +   1.000 E13
                     .112
                    7.714

ASSIGN  =V14 =      1.270*F3    +   1.000 E14
                     .155
                    8.216

FINALEXA=V15 =      1.823*F3    +   1.000 E15
                     .201
                    9.089
```

TITLE: essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

COVARIANCES AMONG INDEPENDENT VARIABLES

```
                              E                                   D
                             ---                                 ---
E5  -FACTS                    3.915*I                                       I
E4  -AXIOMS                    .438 I                                       I
                              8.942 I                                       I
                                    I                                       I
E8  -PRENUM                  13.482*I                                       I
E6  -PRESCORE                 2.542 I                                       I
                              5.305 I                                       I
                                    I                                       I
E9  -POSTNUM                 26.317*I                                       I
E8  -PRENUM                   2.278 I                                       I
                             11.553 I                                       I
                                    I                                       I
E11 -FEEDBACK                  .742*I                                       I
E10 -CRITIQUE                  .149 I                                       I
                              4.979 I                                       I
                                    I                                       I
E12 -ARTICLE                   .360*I                                       I
E11 -FEEDBACK                  .112 I                                       I
                              3.215 I                                       I
                                    I                                       I
```

```
TITLE:   essail
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

STANDARDIZED SOLUTION:                                                    R-SQUARED


NOTES    =V1  =      .895 F1    +    .447 E1                               .801
VIDEO    =V2  =      .953*F1    +    .304 E2                               .907
CHAPTER  =V3  =      .904*F1    +    .427 E3                               .817
AXIOMS   =V4  =      .907*F1    +    .421 E4                               .823
FACTS    =V5  =      .868*F1    +    .497 E5                               .753
PRESCORE=V6   =      .673 F2    +    .740 E6                               .453
POSTSCOR=V7   =      .999*F2    +    .047 E7                               .998
PRENUM   =V8  =      .584*F2    +    .812 E8                               .341
POSTNUM  =V9  =      .571*F2    +    .821 E9                               .326
CRITIQUE=V10  =      .516 F3    +    .857 E10                              .266
FEEDBACK=V11  =      .417*F3    +    .909 E11                              .174
ARTICLE =V12  =      .478*F3    +    .878 E12                              .229
MIDTERM =V13  =      .587*F3    +    .810 E13                              .344
ASSIGN   =V14 =      .655*F3    +    .755 E14                              .430
FINALEXA=V15  =      .861*F3    +    .508 E15                              .742
   F1    =F1  =      .559*F5    +    .829 D1                               .312
   F2    =F2  =      .626*F5    +    .780 D2                               .391
   F3    =F3  =      .821 F5    +    .571 D3                               .674
   F5    =F5  =      .225*V16   +    .344*V17   -    .132*V22
                +    .307*V23   +    .848 D5                               .281
```

TITLE: essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

CORRELATIONS AMONG INDEPENDENT VARIABLES

	E	D
E5 -FACTS E4 -AXIOMS	.765*	
E8 -PRENUM E6 -PRESCORE	.182*	
E9 -POSTNUM E8 -PRENUM	.798*	
E11 -FEEDBACK E10 -CRITIQUE	.296*	
E12 -ARTICLE E11 -FEEDBACK	.178*	

E N D   O F   M E T H O D

TITLE: essai1
EQS/EM386 Licensee: Concordia University
MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

LAGRANGIAN MULTIPLIER TEST REQUIRES 144004 WORDS OF MEMORY.
PROGRAM ALLOCATES 190000 WORDS.

LAGRANGE MULTIPLIER TEST (FOR ADDING PARAMETERS)

ORDERED UNIVARIATE TEST STATISTICS:

NO	CODE		PARAMETER	CHI-SQUARE	PROBABILITY	PARAMETER CHANGE
1	2	4	E9,V22	51.742	0.000	-0.662
2	2	11	V9,V22	51.742	0.000	-2.651
3	2	11	V7,V22	38.019	0.000	9.109
4	2	4	E7,V22	38.019	0.000	2.276
5	2	4	E8,V22	37.384	0.000	0.550
6	2	11	V8,V22	37.384	0.000	2.203
7	2	0	E7,E7	35.672	0.000	156.503
8	2	20	V7,F5	35.274	0.000	-11.527
9	2	1	V23,V17	33.518	0.000	19.142
10	2	6	E9,E7	33.223	0.000	-27.970
11	2	1	V23,V16	33.212	0.000	10.719
12	2	20	V9,F5	31.423	0.000	1.980
13	2	20	V7,F1	29.861	0.000	-1.871
14	2	20	V9,F3	20.945	0.000	1.015
15	2	20	V9,F1	20.138	0.000	0.330
16	2	11	V6,V22	20.090	0.000	-6.037
17	2	4	E6,V22	20.090	0.000	-1.508
18	2	15	F2,V22	17.405	0.000	4.986
19	2	20	V7,F3	14.977	0.000	-4.595
20	2	15	F3,V22	12.584	0.000	-0.462
21	2	6	E3,E2	11.816	0.001	1.089
22	2	6	E12,E10	10.191	0.001	0.491
23	2	4	E7,V17	10.129	0.001	-106.992
24	2	11	V7,V17	10.129	0.001	-0.059
25	2	10	D5,D1	10.080	0.001	-0.747
26	2	22	F5,F1	10.080	0.001	-0.146
27	2	10	D3,D2	10.080	0.001	3.598
28	2	22	F2,F3	10.080	0.001	9.379
29	2	22	F3,F2	10.080	0.001	0.043
30	2	22	F5,F3	9.300	0.002	1.026
31	2	22	F1,F2	9.300	0.002	-0.066
32	2	22	F2,F1	9.300	0.002	-1.085
33	2	10	D2,D1	9.300	0.002	-5.551
34	2	10	D5,D3	9.300	0.002	0.393
35	2	11	V11,V22	8.806	0.003	-0.427
36	2	4	E11,V22	8.806	0.003	-0.107
37	2	4	E8,V17	7.744	0.005	21.851
38	2	11	V8,V17	7.744	0.005	0.012
39	2	15	F1,V16	7.738	0.005	0.017
40	2	20	V15,F2	6.999	0.008	0.029
41	2	11	V4,V16	6.664	0.010	0.008
42	2	4	E4,V16	6.664	0.010	4.602
43	2	20	V14,F2	6.490	0.011	-0.025
44	2	6	E7,E6	6.368	0.012	-40.124
45	2	20	V4,F5	6.329	0.012	0.323
46	2	20	V11,F2	6.318	0.012	0.019
47	2	11	V13,V23	6.150	0.013	0.135
48	2	4	E13,V23	6.150	0.013	0.272
49	2	15	F2,V23	6.086	0.014	1.131
50	2	6	E10,E1	6.067	0.014	-0.351
51	2	20	V4,F2	5.984	0.014	0.016

52	2	6	E11,E8	5.822	0.016	-0.568
53	2	6	E9,E6	5.580	0.018	9.583
54	2	6	E7,E1	5.537	0.019	-2.486
55	2	20	V11,F5	5.398	0.020	0.622
56	2	15	F1,V17	5.250	0.022	0.008
57	2	6	E14,E12	5.190	0.023	-0.319
58	2	4	E10,V23	4.995	0.025	-0.317
59	2	11	V10,V23	4.995	0.025	-0.157
60	2	4	E1,V22	4.678	0.031	-0.088
61	2	11	V1,V22	4.678	0.031	-0.353
62	2	6	E3,E1	4.633	0.031	-0.298
63	2	6	E7,E4	4.537	0.033	2.036
64	2	6	E5,E1	4.423	0.035	0.287
65	2	15	F3,V16	4.385	0.036	-0.006
66	2	6	E13,E11	4.226	0.040	0.202
67	2	4	E15,V23	3.986	0.046	-0.269
68	2	11	V15,V23	3.986	0.046	-0.133
69	2	6	E15,E6	3.980	0.046	2.089
70	2	6	E15,E13	3.976	0.046	-0.310
71	2	20	V3,F5	3.969	0.046	-0.278
72	2	20	V1,F2	3.874	0.049	-0.015
73	2	15	F3,V23	3.623	0.057	-0.096
74	2	4	E9,V23	3.566	0.059	0.502
75	2	11	V9,V23	3.566	0.059	0.249
76	2	11	V15,V22	3.504	0.061	-0.336
77	2	4	E15,V22	3.504	0.061	-0.084
78	2	6	E15,E11	3.482	0.062	-0.247
79	2	11	V7,V16	3.327	0.068	-0.057
80	2	4	E7,V16	3.327	0.068	-33.025
81	2	6	E14,E6	3.222	0.073	-2.034
82	2	6	E12,E8	2.992	0.084	0.453
83	2	6	E9,E1	2.962	0.085	0.471
84	2	6	E14,E13	2.763	0.096	0.224
85	2	6	E15,E14	2.762	0.097	0.360
86	2	6	E11,E7	2.760	0.097	1.549
87	2	4	E7,V23	2.661	0.103	1.795
88	2	11	V7,V23	2.661	0.103	0.889
89	2	6	E10,E2	2.661	0.103	0.413
90	2	6	E14,E9	2.629	0.105	0.503
91	2	6	E7,E5	2.620	0.106	-1.866
92	2	1	V22,V16	2.608	0.106	1.057
93	2	6	E15,E12	2.515	0.113	0.237
94	2	6	E13,E1	2.506	0.113	0.174
95	2	15	F3,V17	2.483	0.115	-0.003
96	2	20	V3,F3	2.464	0.116	-0.146
97	2	11	V13,V17	2.407	0.121	-0.003
98	2	4	E13,V17	2.407	0.121	-5.187
99	2	4	E5,V16	2.394	0.122	-3.328
100	2	11	V5,V16	2.394	0.122	-0.006
101	2	6	E10,E8	2.357	0.125	0.483
102	2	20	V4,F3	2.301	0.129	0.130
103	2	20	V5,F2	2.237	0.135	-0.012
104	2	11	V4,V23	2.222	0.136	0.078
105	2	4	E4,V23	2.222	0.136	0.158
106	2	20	V3,F2	2.182	0.140	-0.011
107	2	20	V10,F5	2.172	0.141	-0.536
108	2	6	E14,E11	2.158	0.142	-0.182
109	2	4	E8,V16	2.132	0.144	6.361
110	2	11	V8,V16	2.132	0.144	0.011
111	2	20	V14,F5	2.128	0.145	-0.545
112	2	6	E15,E9	2.078	0.149	0.413
113	2	6	E11,E6	1.976	0.160	1.237
114	2	6	E11,E9	1.956	0.162	0.337
115	2	20	V6,F3	1.871	0.171	1.108
116	2	4	E3,V22	1.809	0.179	0.053
117	2	11	V3,V22	1.809	0.179	0.214
118	2	6	E10,E9	1.789	0.181	-0.431

119	2	4	E8,V23	1.655	0.198	-0.334
120	2	11	V8,V23	1.655	0.198	-0.166
121	2	6	E13,E12	1.630	0.202	-0.141
122	2	6	E10,E6	1.613	0.204	1.494
123	2	6	E6,E2	1.610	0.205	2.254
124	2	6	E13,E4	1.605	0.205	-0.126
125	2	20	V14,F1	1.593	0.207	0.053
126	2	6	E14,E7	1.541	0.214	-1.516
127	2	20	V12,F1	1.416	0.234	-0.042
128	2	1	V22,V17	1.342	0.247	1.348
129	2	20	V15,F5	1.322	0.250	0.517
130	2	20	V6,F5	1.320	0.251	1.483
131	2	4	E11,V16	1.313	0.252	-2.011
132	2	11	V11,V16	1.313	0.252	-0.003
133	2	4	E5,V23	1.248	0.264	-0.143
134	2	11	V5,V23	1.248	0.264	-0.071
135	2	6	E6,E3	1.240	0.265	-1.087
136	2	6	E9,E3	1.228	0.268	0.296
137	2	20	V12,F2	1.218	0.270	-0.009
138	2	20	V8,F3	1.212	0.271	-0.239
139	2	20	V12,F5	1.182	0.277	-0.328
140	2	11	V13,V22	1.178	0.278	-0.162
141	2	4	E13,V22	1.178	0.278	-0.040
142	2	11	V14,V22	1.142	0.285	0.200
143	2	4	E14,V22	1.142	0.285	0.050
144	2	11	V10,V22	1.135	0.287	0.206
145	2	4	E10,V22	1.135	0.287	0.051
146	2	20	V5,F5	1.126	0.289	-0.164
147	2	4	E3,V23	1.123	0.289	-0.121
148	2	11	V3,V23	1.123	0.289	-0.060
149	2	6	E7,E3	1.103	0.294	-1.083
150	2	6	E5,E3	1.098	0.295	-0.140
151	2	4	E3,V17	1.094	0.296	-3.619
152	2	11	V3,V17	1.094	0.296	-0.002
153	2	11	V4,V17	1.093	0.296	0.002
154	2	4	E4,V17	1.093	0.296	3.352
155	2	6	E15,E8	1.077	0.299	-0.291
156	2	6	E12,E5	1.073	0.300	0.134
157	2	4	E9,V16	0.942	0.332	4.326
158	2	11	V9,V16	0.942	0.332	0.007
159	2	6	E12,E6	0.938	0.333	-0.947
160	2	6	E8,E1	0.879	0.348	-0.251
161	2	20	V1,F5	0.858	0.354	-0.132
162	2	11	V11,V23	0.853	0.356	0.048
163	2	4	E11,V23	0.853	0.356	0.098
164	2	6	E12,E9	0.848	0.357	-0.246
165	2	6	E4,E2	0.840	0.359	-0.216
166	2	6	E8,E5	0.838	0.360	0.268
167	2	6	E15,E2	0.829	0.363	-0.206
168	2	11	V10,V17	0.805	0.369	-0.002
169	2	4	E10,V17	0.805	0.369	-3.872
170	2	6	E8,E2	0.805	0.370	-0.426
171	2	4	E1,V23	0.801	0.371	-0.105
172	2	11	V1,V23	0.801	0.371	-0.052
173	2	6	E14,E8	0.783	0.376	-0.268
174	2	4	E14,V16	0.769	0.380	-2.001
175	2	11	V14,V16	0.769	0.380	-0.003
176	2	6	E15,E10	0.748	0.387	-0.158
177	2	11	V11,V17	0.746	0.388	0.002
178	2	4	E11,V17	0.746	0.388	2.776
179	2	6	E11,E5	0.733	0.392	-0.100
180	2	6	E14,E3	0.726	0.394	0.114
181	2	6	E6,E4	0.697	0.404	-0.756
182	2	6	E12,E7	0.640	0.424	-0.831
183	2	6	E9,E4	0.636	0.425	-0.198
184	2	6	E11,E4	0.603	0.437	0.075
185	2	20	V8,F5	0.601	0.438	-0.268

186	2	6	E8,E7	0.601	0.438	4.912
187	2	6	E14,E1	0.594	0.441	0.106
188	2	4	E9,V17	0.578	0.447	6.108
189	2	11	V9,V17	0.578	0.447	0.003
190	2	4	E5,V22	0.556	0.456	0.033
191	2	11	V5,V22	0.556	0.456	0.133
192	2	6	E14,E10	0.549	0.459	0.125
193	2	6	E10,E7	0.518	0.472	-0.901
194	2	6	E13,E6	0.504	0.478	-0.644
195	2	11	V12,V17	0.489	0.485	0.001
196	2	4	E12,V17	0.489	0.485	2.505
197	2	6	E15,E4	0.469	0.493	0.079
198	2	6	E15,E3	0.466	0.495	-0.085
199	2	11	V6,V23	0.455	0.500	-0.325
200	2	4	E6,V23	0.455	0.500	-0.655
201	2	6	E14,E4	0.394	0.530	-0.078
202	2	20	V13,F5	0.389	0.533	0.180
203	2	6	E12,E4	0.377	0.539	-0.066
204	2	11	V2,V23	0.364	0.546	0.063
205	2	4	E2,V23	0.364	0.546	0.126
206	2	6	E12,E2	0.364	0.547	-0.127
207	2	6	E6,E1	0.350	0.554	0.592
208	2	6	E14,E5	0.347	0.556	0.088
209	2	11	V5,V17	0.343	0.558	0.001
210	2	4	E5,V17	0.343	0.558	2.267
211	2	11	V1,V17	0.341	0.559	-0.001
212	2	4	E1,V17	0.341	0.559	-2.069
213	2	6	E13,E7	0.337	0.561	0.563
214	2	4	E10,V16	0.335	0.563	-1.362
215	2	11	V10,V16	0.335	0.563	-0.002
216	2	6	E5,E2	0.334	0.563	-0.153
217	2	4	E14,V17	0.333	0.564	-2.426
218	2	11	V14,V17	0.333	0.564	-0.001
219	2	4	E12,V22	0.327	0.567	-0.023
220	2	11	V12,V22	0.327	0.567	-0.092
221	2	6	E4,E3	0.301	0.583	0.063
222	2	1	V23,V22	0.294	0.588	0.021
223	2	6	E13,E2	0.278	0.598	0.103
224	2	6	E12,E3	0.263	0.608	-0.059
225	2	11	V12,V23	0.226	0.634	-0.028
226	2	4	E12,V23	0.226	0.634	-0.056
227	2	20	V13,F1	0.208	0.648	0.015
228	2	11	V4,V22	0.206	0.650	-0.067
229	2	4	E4,V22	0.206	0.650	-0.017
230	2	6	E10,E3	0.194	0.660	0.061
231	2	6	E2,E1	0.191	0.662	-0.135
232	2	20	V5,F3	0.190	0.663	-0.045
233	2	15	F1,V23	0.184	0.668	-0.046
234	2	20	V15,F1	0.181	0.671	-0.019
235	2	6	E8,E3	0.166	0.684	0.106
236	2	11	V13,V16	0.148	0.701	-0.001
237	2	4	E13,V16	0.148	0.701	-0.700
238	2	6	E15,E1	0.143	0.705	0.048
239	2	20	V10,F1	0.133	0.715	-0.015
240	2	6	E13,E5	0.129	0.720	0.043
241	2	6	E9,E2	0.125	0.724	0.172
242	2	6	E11,E3	0.124	0.725	-0.037
243	2	6	E13,E3	0.115	0.735	-0.036
244	2	6	E14,E2	0.108	0.743	-0.080
245	2	15	F2,V17	0.097	0.755	-0.005
246	2	4	E3,V16	0.094	0.759	-0.589
247	2	11	V3,V16	0.094	0.759	-0.001
248	2	6	E10,E5	0.092	0.762	-0.047
249	2	4	E6,V16	0.084	0.771	-4.732
250	2	11	V6,V16	0.084	0.771	-0.008
251	2	6	E8,E4	0.080	0.777	0.069
252	2	20	V2,F2	0.074	0.786	0.004

253	2	6	E4,E1	0.070	0.791	-0.031
254	2	11	V14,V23	0.067	0.796	0.018
255	2	4	E14,V23	0.067	0.796	0.036
256	2	15	F1,V22	0.065	0.798	-0.073
257	2	20	V1,F3	0.065	0.799	-0.024
258	2	11	V2,V22	0.056	0.814	0.068
259	2	4	E2,V22	0.056	0.814	0.017
260	2	6	E13,E10	0.055	0.814	-0.031
261	2	6	E12,E1	0.055	0.815	0.028
262	2	6	E15,E7	0.050	0.823	0.268
263	2	4	E1,V16	0.038	0.844	-0.386
264	2	11	V1,V16	0.038	0.844	-0.001
265	2	6	E13,E8	0.027	0.869	-0.040
266	2	11	V2,V16	0.023	0.879	-0.001
267	2	4	E2,V16	0.023	0.879	-0.532
268	2	20	V13,F2	0.021	0.884	0.001
269	2	6	E10,E4	0.020	0.886	0.018
270	2	6	E11,E1	0.018	0.894	0.014
271	2	4	E12,V16	0.017	0.895	0.258
272	2	11	V12,V16	0.017	0.895	0.000
273	2	20	V11,F1	0.016	0.898	0.004
274	2	11	V2,V17	0.016	0.900	0.000
275	2	4	E2,V17	0.016	0.900	0.796
276	2	15	F2,V16	0.012	0.911	-0.003
277	2	20	V2,F3	0.012	0.915	-0.018
278	2	6	E7,E2	0.010	0.922	-0.184
279	2	20	V2,F5	0.009	0.925	0.024
280	2	11	V6,V17	0.008	0.927	0.001
281	2	4	E6,V17	0.008	0.927	2.703
282	2	20	V6,F1	0.008	0.929	-0.024
283	2	6	E9,E5	0.007	0.932	-0.026
284	2	6	E11,E2	0.005	0.944	-0.013
285	2	22	F3,F1	0.005	0.945	0.003
286	2	10	D5,D2	0.005	0.945	-0.074
287	2	22	F5,F2	0.005	0.945	-0.001
288	2	10	D3,D1	0.005	0.945	0.015
289	2	22	F1,F3	0.005	0.945	0.040
290	2	20	V8,F1	0.003	0.956	-0.004
291	2	20	V10,F2	0.003	0.959	-0.001
292	2	11	V15,V16	0.002	0.969	0.000
293	2	4	E15,V16	0.002	0.969	-0.087
294	2	6	E13,E9	0.001	0.972	-0.009
295	2	4	E15,V17	0.001	0.981	-0.099
296	2	11	V15,V17	0.001	0.981	0.000
297	2	6	E15,E5	0.000	0.983	-0.003
298	2	6	E6,E5	0.000	0.995	0.006
299	2	0	F3,F5	0.000	1.000	0.000
300	2	0	V10,F3	0.000	1.000	0.000
301	2	0	F1,D1	0.000	1.000	0.000
302	2	0	V6,F2	0.000	1.000	0.000
303	2	0	V1,F1	0.000	1.000	0.000
304	2	0	F5,D5	0.000	1.000	0.000
305	2	0	F3,D3	0.000	1.000	0.000
306	2	0	F2,D2	0.000	1.000	0.000
307	2	1	V17,V16	0.000	1.000	0.000

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MAXIMUM LIKELIHOOD SOLUTION (NORMAL DISTRIBUTION THEORY)

MULTIVARIATE LAGRANGE MULTIPLIER TEST BY SIMULTANEOUS PROCESS IN STAGE 1

PARAMETER SETS (SUBMATRICES) ACTIVE AT THIS STAGE ARE:

PVV PFV PFF PEV PEF PEE PDD GVV GVF GFV GFF BVF BFF

	CUMULATIVE MULTIVARIATE STATISTICS				UNIVARIATE INCREMENT	
STEP	PARAMETER	CHI-SQUARE	D.F.	PROBABILITY	CHI-SQUARE	PROBABILITY
1	E9,V22	51.742	1	0.000	51.742	0.000
2	V23,V17	85.260	2	0.000	33.518	0.000
3	V23,V16	118.473	3	0.000	33.212	0.000
4	E7,E7	151.151	4	0.000	32.678	0.000
5	E7,E6	181.232	5	0.000	30.081	0.000
6	F2,V22	198.693	6	0.000	17.461	0.000
7	F5,F3	210.624	7	0.000	11.931	0.001
8	E3,E2	222.440	8	0.000	11.816	0.001
9	E12,E10	232.631	9	0.000	10.191	0.001
10	V11,V22	240.921	10	0.000	8.290	0.004
11	V9,F1	248.802	11	0.000	7.881	0.005
12	V6,V22	256.457	12	0.000	7.655	0.006
13	E7,V17	263.845	13	0.000	7.388	0.007
14	E13,V23	271.688	14	0.000	7.844	0.005
15	V14,F2	279.087	15	0.000	7.398	0.007
16	E10,E1	285.272	16	0.000	6.186	0.013
17	V4,V16	291.417	17	0.000	6.145	0.013
18	E11,E8	297.536	18	0.000	6.119	0.013
19	V11,F2	302.895	19	0.000	5.359	0.021
20	E13,E11	308.697	20	0.000	5.802	0.016
21	E14,E12	313.902	21	0.000	5.205	0.023
22	E7,E4	319.102	22	0.000	5.200	0.023
23	E8,V17	324.098	23	0.000	4.996	0.025
24	E9,E7	329.582	24	0.000	5.484	0.019
25	E15,E6	334.094	25	0.000	4.512	0.034
26	F1,V16	338.570	26	0.000	4.476	0.034
27	E7,E1	342.570	27	0.000	4.000	0.045

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Execution begins at 13:57:52.20
Execution ends at 13:57:54.45
Elapsed time = 2.25 seconds