Changing Pedagogy: The Introduction of Experiential, Cooperative Learning and Interactive Multimedia into the Statics Learning Environment

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Abstract

Teacher change is about moving from thought, feelings and an understanding of teaching and learning into action and practice (Fullan, 1982). This naturalistic case study describes the initial phases of the teacher change process resulting from the implementation of a restructured undergraduate statics engineering course. The investigation focused on the broad research question of what happens when an educator undertakes the teacher change process to allow himself to move away from what is familiar and known (i.e., the traditional pedagogy) into an unknown, new pedagogy. More specifically, the three research questions investigated by this study were : (a) what were the teacher's intentions for changing his pedagogy? (b) what were the actual teaching events over the course of the semester? (c) what were the participants' (i.e., the instructor, students, undergraduate teaching assistant and researchers) perceptions of the pedagogical change?

The collection and analysis of the data occurred simultaneously throughout the Fall semester of 1995, and continued into April 1996. Data were collected from transcribed audio recordings of interviews with the instructor, selected students and the undergraduate teaching assistant, written field notes from observations, questionnaires, electronic mail exchanges, student minute papers, and other documents. The data were summarized and coded according to recurring words, phrases, sentences and paragraphs about the instructor's intent for his change in pedagogy, then organized into categories of three change foci : (a) experiential learning, (b) cooperative learning, and (c) interactive multimedia in order to correspond with his intent for the new statics learning environment. Data were displayed in charts and tables to determine issues related to change.

The results of this study are presented in terms of a descriptive analysis of the initial teacher change process portrayed through the "multiple realities" of the participants who experienced the pedagogical change. Three issues were evident : (a) the problem of the simultaneous introduction of three new innovations (experiential, cooperative learning and the interactive multimedia), (b) the frustrations of the teacher change process, and (c) difficulties of a paradigm shift in pedagogy when the instructor commences to relinquish control in the new learning environment. Articulation of these issues helps to increase our understanding of the teacher change process and the need to enact change over time. Moreover, lessons learned from this study can serve as guidelines for future researchers in their efforts to study the change process. This study increases our understanding of the teacher change process particularly when one undertakes a paradigm shift in pedagogy.

Dedication

I would like to dedicate this dissertation to my family, in particular to my father, Michele Bavaro who tragically passed away during the final stages of this dissertation.

> *" Dad, I will never for one moment forget the advice you gave me. You showed such courage and dignity in the face of death. Remember, that you have always been and will continue to be my inspiration in all that I do"*.

To my mother, Anna Bavaro who has shown great strength whilst moving into a new phase of her life and establishing her new identity. To my much younger sister, Lina, you have always been there for me. I will never forget the courage and strength you have shown during a most difficult time of our lives. Thank you for the persistent encouragement and support throughout the pursuit of this degree.

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To Professor Sparks, without whom there would not have been a study, his financial support enabled me to complete this dissertation. I would like to thank you for allowing me into your new statics learning environment. Please remember,

> *In my zeal to make their lives as learners better, I forget that change is relative (it exists in time and space); that change is in flux, the contexts in which change occurs are constructed, deconstructed and reconstituted both socially and personally...I tend to forget that change is a kind of continuous adaptation-not an end in itself. (Kahaney, 1993, p.194).*

The emotional and intellectual support of my friends was prodigious and an essential component to getting through this degree. In particular, thank you Dr. Barbara Lockee who unselfishly, while trying to complete her own dissertation conducted observations and interviews during my return to Australia. I would also like to thank Dr. Wayne and Dr. Glenda Scales as well as Dr. Barbara Lockee and Bob Lockee who never deserted me, and with the help of my sister, Lina kept me sane the weeks prior to my defense and taught me the true meaning of friendship. It is these close friendships that I will warmly remember when I think about the time I spent in North America.

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Chapter 1

Introduction

How to introduce effective change has increasingly frustrated and mystified educators over the past few decades (Fullan, 1982). When one discusses change then one needs to define what is meant by the word. Change is about making something different. It is described in the literature as an ongoing, complex process rather than a single event (Hall & Loucks, 1977; Fullan, 1982; Fullan & Park, 1981) or a permanent, measurable product (Kahaney, 1993).

When one undertakes change they are entering into a journey of uncertainty (Fullan, 1994). In regards to teacher change Marris (1975) asserts that change is a struggle that many educators fail to recognize as natural and inevitable. Fullan (1994) adds, " Change is ubiquitous and relentless, forcing itself on us at every turn. At the same time, the secret of growth and development is learning how to contend with the forces of change..." (p. vii).

The teacher change process may come about because it is either imposed on a teacher by a higher authority or the teacher voluntarily chooses to participate or initiate the process. This dissertation describes the initial phase of the teacher change process undertaken voluntarily by a civil engineering professor who was dissatisfied with the way the traditional statics course was designed. His goal was to transform the curriculum and pedagogy based on his newly found understandings of learning theory and multimedia technology.

Fundamental to any engineering and architectural program, the study of statics is concerned with the computation of forces acting upon bodies in equilibrium. Statics combines the principles of engineering and applied mathematics, it has been traditionally taught through didactic lecture based instruction. The new learning environment was designed to replace this traditional instruction with the new pedagogical tools of experiential, cooperative learning and interactive multimedia.

Literature Review

This chapter is organized beginning with a general discussion of the change process, and focuses on the specifics of the context and content applicable to this study. First, a literature review on educational and teacher change is presented. Then, the literature concerning current trends in curriculum and pedagogical change such as the "new" view of learning and teaching are addressed. Finally, the chapter closes with a discussion and the specific events prompting this research.

Educational Change

Fullan (1982) identifies four broad phases, initiation, implementation, continuation and outcome of educational change (see Figure 1.1 below). The two-way arrows imply that change is not a linear process, but an interactive one that requires feedback and decision making at each phase.

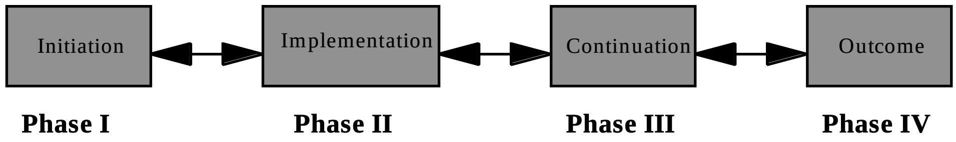

Figure 1.1 A simplified overview of the change process.

The first phase is the initiation of the change. Initiation begins with the processes which lead up to and include decisions to proceed with change by developing or adopting an innovation. Innovations are usually developed in response to sponsored incentive systems in society such as government sponsorship. The change process may come about because it is either imposed on a teacher by a higher authority or the teacher voluntarily chooses to participate or alternately, initiates the process (Fullan,1982).

The second phase is the implementation of the change which involves the change in practice. Implementation focuses on the first experiences of attempting to put an idea, a program or innovation into practice. Fullan (1982) highlights the difficulty of explaining the notion of change in practice because change is not one single entity and is considered to be multidimensional. He proposes three components or dimensions to the implementation of a new program or innovation. They include, the use of new or revised materials such as, curriculum materials and new technologies, the use of new teaching approaches or strategies, and the alteration beliefs such as, the pedagogical assumptions and theories underlying the new program. All three dimensions of change are necessary because they represent the means of achieving a goal. However, it is clear that any individual may implement none, one, two, or all three dimensions. For example, a teacher could use new technologies and alter teaching strategies without totally coming to grips with the conceptions or beliefs underlying the change. The time line for the implementation phase is somewhat arbitrary unless a specific period has been agreed upon. This is sometimes linked to external funding such as government sponsorship.

The third phase is the continuation of the change. This is a phase where the change is sustained and continued beyond the first year or two of implementation or whenever the change has been institutionalized or permanently incorporated into a system. An example would be the case when a new program or innovation is incorporated permanently into a curriculum. Time is a variable of the educational change process since the total time perspective from initiation to continuation cannot be precisely demarcated (Fullan, 1982; Fullan & Park, 1981). However, Fullan (1982) recommends that," The total time frame from initiation to institutionalization is lengthy; even moderately complex changes take from three to five years " (p.41).

The final phase is the outcome of the change. This phase refers to the several different types of results from the change process. The results can include improved student learning and attitudes, new teacher skills, attitudes and satisfaction. Outcomes can be assessed in the short term, but one could not expect many results until the change had a chance to become implemented for example, over a period of at least five years (Fullan, 1982). In this sense, implementation is the means by which outcomes are achieved in the educational change process.

The most important idea from Figure 1.1 is that change is a process, not an specific event. Fullan (1982) posits that many educators do not understand the process concept of change because too often they place all their energies into developing a program or innovation without thinking through what would happen beyond that point.

Contemporary research has identified the following factors: teacher collaboration and collegiality (Erickson, 1994; Fullan, 1982, 1994; Little, 1981, 1987), changes in beliefs about teaching and learning (Fullan, 1982; Madsen-Nason 1988), thinking and reflection about teaching practice (Edwards, 1994; Erickson, 1994; Fullan, 1994; Slater, 1994), time and frustration (Fullan, 1994; Slater, 1994) as variables that influence teacher change. First, Little's (1981) study of six schools highlighted the importance of collegiality as a variable in the teacher change process. Little (1987) argues that by working closely with colleagues, teachers derive instructional range, depth and flexibility, and that collegiality helps them to gain job satisfaction and shape their perspectives on their daily work. Fullan (1982) also supports the importance of collegiality, he argues that the degree of change is strongly related to the extent to which teachers interact with each other. Within an educational setting, collegiality and mutual support are strong indicators for the successful implementation of an innovation.

A more recent study by Erickson (1994), who conducted a two-year case study of a sixth grade mathematics teacher concluded that support and collaboration from colleagues are vital during teacher change. He also discussed the importance of experiential, "hands-on" pedagogy as a form of assisting teachers who are undergoing change. Moreover, Martin (1993), further adds that teachers are also learners, and their learning happens at their workplace. Consequently, a change in pedagogy occurs during teaching practice and interaction with peers.

Significant educational change consists of changes in beliefs and teaching practice through a process of personal development within a context of socialization (Fullan, 1982). Studies by Edwards (1994), Erickson (1994), Fullan (1994) and Slater (1994) confirm that changes in teaching practice are related to thinking and reflecting on the teaching practice undertaken by the teacher . Reflective practice is defined as, "a mode that integrates or links thought and action with reflection" (Imel, 1992, p.1). The teachers from these studies continually thought about and critically analyzed their actions with the goal of improving their teaching practice. Collegial relationships and classroom consultation with peers provided a means for reflection, and translating thoughts and beliefs into practice. Nevertheless, Madsen-Nason (1988) argues that changing a teacher's beliefs about instruction and learning should precede changing teaching practice.

Research affirms the frustrating, time consuming and often discouraging process that teachers undertaking change have experienced (Fullan, 1994; Fullan & Hargreaves, 1992; Slater, 1994). Slater (1994), for example, spent four years observing and interviewing a beginning mathematics teacher, Pia Hernandez. From this case study she concluded that the journey undertaken by a teacher during the process of change encompassed many inconsistencies regarding Pia's beliefs about teaching and learning and changes to her teaching practice. During the time of the study Pia Hernandez changed from a traditional paradigm to one that incorporated cooperative learning. The findings emphasized the need for reflection on teaching practice including the teacher's beliefs about teaching and learning.

<u>Curriculum and Pedagogical Change in the Nineties</u>

Since the early work of John Dewey (1933), Jean Piaget (1954) and Jerome Bruner (1964) idealized visions of progressive learning environments have evolved in the literature. Mayer (1992) also affirms that the view of a learner as a constructor of knowledge has had numerous proponents in the past such as Barlett (1932) and Tolman (1932). However, it was not until educational research started focusing on learning in realistic situations and settings that views about learning started to change from a learner being a recipient of knowledge to one of a constructor of knowledge (Brown, Collins & Duguid, 1989).

In the nineties we are witnessing a return to this progressive shift because contemporary research concludes that the traditional view of teaching and learning (i.e., the transmission of knowledge from the teacher to the learner) is inadequate (Brown, Bransford, Ferrara, Campione, 1983; Greeno, 1980; Laboratory of Comparative Human Cognition, 1983). During the last few years the literature has directed educators to radically review their thinking about instruction and the design of learning environments (Elmore, 1992; Leinhardt, 1992; Mayer, 1992; Prawat, 1992). Concurrently, the renewed interest in the view of the learner as a constructor of knowledge has appeared in the research (Anderson, 1989; Honebein, Duffy, & Fishman, 1992; Jonassen, Mayes & McAleese, 1992; Knuth & Cunningham, 1992 ; Winn, 1992). The changes that are emerging in the literature are advocating a dramatic shift from the traditional view of learning and teaching (Brandt, 1992; Brooks & Brooks, 1993).

The "new" view of the learner. We are moving from an epistemology where, " Learning is something a learner does, not something that is done to a learner " (Johnson, Johnson & Holubec, 1994, p. 103). From a historical perspective Mayer (1992) outlined three metaphors (a) learning as response acquisition, (b) learning as knowledge acquisition, and (c) learning as knowledge construction when describing changes in the view of learning during the past century. The response acquisition view of learning, prominent in the 1900's to the 50's is described as a "mechanistic process" where an individual's responses were strengthened or weakened by environmental feedback. Within this view the learner is considered to be passive and their behavior is determined by the rewards and punishments in the learning environment. The role of the teacher is to elicit responses and provide reinforcement for correct responses. This view of learning later changed in the 1960's and 70's to a view of learning as knowledge acquisition, which referred to the learner as a processor of information dispensed by the teacher. Learning as a knowledge acquisition metaphor has implications for instruction because it focuses on basic information from textbooks and lectures so that students can acquire knowledge (Mayer, 1992).

Contemporary research does not promote a knowledge base of mere facts as the main goal of instruction. In fact, it affirms that the dominant view of the transmission of knowledge or knowledge acquisition is deficient (Brown, Bransford, Ferrara, Campione, 1983; Greeno, 1980; Laboratory of Comparative Human Cognition, 1983). From this perspective, the aim of pedagogy is to provide well structured presentations of materials primarily through lecture, demonstration and recitation (Mehan, 1979), and to provide the learner with information from textbooks (Mayer, 1992). Johnson, Johnson and Holubec (1994), point out that in traditional lectures, " The information passes from the notes of the professor to the notes of the students without passing through the mind of either one." (p. 49). Furthermore, substantial evidence also indicates that curricula is poorly designed and not used effectively to promote subject matter understanding (e.g., Crosswhite, Dossey, Swafford, McKnight & Cooney, 1985; Driver, Guesne & Tiberghien, 1985; Harns & Yaeger, 1981; Holdzom & Lutz, 1984; McDermott, 1984; Resnick, 1988). Moreover, for most students, traditional curricula is presented as isolated components of knowledge rather than the integration of concepts and skills.

In the 80's and 90's the view of learning as knowledge acquisition was proceeded by the learner as, " a constructor of knowledge" (Mayer, 1992). This is where the teacher becomes a co-participant with the learner in the process of constructing meaning and new knowledge. Contemporary research promotes the learner acquiring facts and theories as conceptual tools for reasoning and problem solving (Bransford, Hasselbring, Baron, Kulewicz, Littlefield & Goin, 1987; Brown et al., 1983; Cognition & Technology at Vanderbilt, 1990; Cole & Griffin, 1987). This was also referred to by Pea and Gomez

(1992) as, “facts in use”. The knowledge base for learners should not be inert and memorized for recall on tests and examinations. Instead learning should promote knowledge construction where new knowledge is connected to previous knowledge through experiences (Resnick, 1984), and should relate to or be “anchored” to the learner’s experiences (Cognition & Technology Group, 1990).

Educators are directed to engage learners in experience based, authentic tasks like those encountered in real life practice (Brown, Collins & Duguid, 1989; Duffy & Jonassen, 1992; Jonassen, 1993). We are moving from learning and teaching in a decontextualized setting to a framework which establishes connections with real life problems. Brown et al. believe that understanding and knowledge is "indexed" by experience, and thus understanding is embedded in the experience of the individual. The notion of experience includes the physical context and the cognitive tasks that a learner engages in while in the environment (Honebein, Duffy & Fishman, 1992). It is argued that knowledge is acquired in functional contexts with similarities to real life practices for future knowledge transfer (Pea, 1987).

One perspective that has influenced the “new” view of the learner is the work of Vygotsky (1978). Vygotsky viewed learning as a developmental process requiring a social environment for the internalization and transformation of new understanding and cultural tools for the externalization of the mind. He proposed that learning depended on the prior existence of complex cognitive structures, such as tools (e.g., physical materials, linguistic tools) and resources (e.g. such as technology) situated externally in the culture (or learning environment) and internalized by the learner. Newman, Griffin and Cole (1989), describe this process as the interpsychological (internal) and the intrapsychological (external) socio-cultural perspective of learning. They propose the notion of "cognitive change" to outline the constructive nature of learning that occurs between social and communicative interaction mediated through the culture and the learner's internal processes.

The internal and external constructive processes transpire simultaneously during an individual's participation in learning tasks with more capable others. Ideally, it is the adult's role to model a solution to a problem to engage and monitor the individual's current level of skill, and then to support or "scaffold" the individual's extension skills and knowledge to a higher level of competence. Social interaction with people who are experts in the use of material and tools provide an important "cultural amplifier" to extend the individual's cognitive processes (Gallimore & Tharp, 1993).

The zone of proximal development is one of the most influential concepts that Vygotsky introduced to education because it explains when, where, how and with whom learning occurs (Gallimore & Tharp, 1993). In a broad sense, the zone of proximal development or ZPD is the location where teacher and students interact and co-participate in the learning process. Consequently, new understandings arise for the learner and the teacher. It is the social interactions in the ZPD that accommodates the constructive process of learning or cognitive change.

Collaborative learning also draws support from the research of Vygotsky's assistance of capable others in the zone of proximal development (Tudge, 1994). Vygotsky’s (1978) position stressed collaboration with capable others in the zone of proximal development to socially construct meaning. It is through experiences of imitation, communication amongst individuals and interaction with resources and tools from the learning environment, that tasks are enacted and practiced until they are internalized by the learner.

The changing role of teaching. As our view of the learner changes so does our view of the role of the teacher. One current issue is that traditional education espouses belief systems of authority-centered epistemology and a role of knowledge acquisition for the learner. This traditional paradigm for teaching is to transfer the teacher's knowledge to passive students (Brown et al., 1989; Cole & Griffin, 1987; Mehan, 1979; Schoenfield, 1985). Teaching in the nineties is changing from being a deliverer of information where communication is not viewed as merely a one-way transmission from the instructor to the learner. Moreover, it is a two-way process that enables the progressive construction of meaning through action and dialogue. These conversations are the means by which people articulate differences and then construct collaboratively a common ground of shared beliefs, meanings, and understandings. They are part of the cognitive change that the learner undertakes. The Cognition and Technology Group at Vanderbilt (CTGV) (1992), presents an interesting viewpoint regarding discourse, negotiated meaning and knowledge construction. They reason that without a community, it is possible for an individual to have an idiosyncratic view of the world. As soon as there are multiple views, one of many things may occur, e.g., an agreement transpires, the individuals disagree or the individuals may negotiate common meaning. The CTGV state :

> Knowledge is a dialectic process, the essence of which is that individuals have opportunities to test their constructed ideas on others, persuade others of the virtue of their thinking and be persuaded. By continually negotiating the meaning of observations, data, hypothesis and so forth, groups of individuals construct systems that are largely consistent with one another. (The Cognition and Technology Group at Vanderbilt, 1992, p.10).

With new conceptualizations of the learner, there comes a new understanding of the teacher's role which is to, " ... model inquiry, provoke inquiry oriented to student's conceptual change from pre-existing alternative conceptions of the subjects domain, negotiate meanings in discourse with students, and serve to represent a community of scientific practice " (Pea & Gomez, 1992, p. 82). If one believes that learners create, revise, and contribute not only to their own knowledge but to that of a culture, an educator then needs to create a community in which all members of the group participate in thinking and problem solving (Brophy & Good, 1986; Brown, 1994; Collins, Brown & Newman, 1989; Hawkins & Pea, 1987; Lampert, 1990; Resnick, 1987).

Several kind of activities appear to contribute to the establishment of such a community (Pea & Gomez, 1992) . Educators are directed to work on real problems, and encouraged to think aloud while arriving at a solution. They should consider including problems that are novel and for which answers are not immediately apparent. Educators should describe their reasons for making certain decisions. They should solicit learner contributions to this process and assign students to roles or sub tasks in complex collaborative problem solving and rotates these roles. Finally, they should encourage group discussions to take place so that students can reflect on and consolidate what has been learned.

Real applications of knowledge are at the core of instruction. Students are "scaffolded" as they become increasingly more proficient in taking on parts of the whole task, with instructional support fading as competencies are achieved (Brown & Palincsar, 1989; Collins et al., 1989). Teaching is said to occur, "...when assistance is offered at points in the zone of proximal development at which performance requires assistance " (Gallimore & Tharp, 1993, p. 41), and learning results from the transition to self assistance when the learner internalizes the task. Assistance to the learner is provided through instruction, feedback, contingency management, questioning and cognitive structuring (Gallimore & Tharp, 1993). When teaching is considered as assisting the performance of learners, it becomes a vehicle through which the interactions of social and cultural environment are internalized by the individual. Such definitions of teaching are grounded in Vygotsky's theory of development and provide a basis for understanding the teaching and learning process.

The promise and role of technology. The Laboratory for Comparative Human Cognition (1983), Papert (1980), and Weir (1989) present the viewpoint that computer technology will significantly change the nature of teaching and learning to a more student centered and cooperative, individualized learning environment. Unfortunately, there is little evidence that computers have produced noticeable changes in traditional schooling. Kulik, Kulik and Cohen's (1980) meta-analysis containing 59 independent evaluations of computer-based college teaching showed that computer-based instruction made a small contribution to the course achievement of undergraduate college students when examination performance was used in the analysis. In 37 of the studies computer based instruction (CBI) examination performance was superior to examination results in conventional classes. However, 14 of the comparisons reported statistically significant differences in teaching methods of the studies examined. Furthermore, there is also the viewpoint that many authors believe that putting computers in the learning environment will not in itself lead teachers to view teaching and learning differently (Cuban, 1986; Pearlman, 1989; Hannafin & Savenye, 1993). The lecture and text-based model in higher education is so strongly entrenched, that it will not be supplanted or altered by any medium in the future (Johnson, Johnson & Holubec, 1994).

Recent advances in theoretical orientations have also fueled a rapid and extensive revolution in computer supported learning environments. In the nineties, interactive multimedia is the medium being heralded as the next tool that will revolutionize computer supported learning environments and consequently, teaching and learning in higher education (Lamb, 1992). Multimedia is defined as the use of multiple formats for the presentation of information, including text, still or animated graphics, movie segments, video and audio information, computer based interactive multimedia also includes hypermedia and hypertext (Tolhurst, 1995). Hartman, Diem and Quagliana (1992), put forward the viewpoint that this type of technology has the potential to store enormous quantities of information and retrieve that information readily. Interactive multimedia provides a framework which offers opportunities for learners to construct and reconstruct their knowledge. There is the assumption that interactive multimedia offers a number of significant benefits to the teaching and learning process. Interactive multimedia provides a promising area for exploring the development of integrated knowledge that is difficult to achieve through traditional instruction (Goldman & Barron, 1990).

The academic engineering community is not immune to the developments of computer supported learning environments (Onaral, 1990). The use of multimedia-based curricular materials has rapidly gained popularity in engineering education during the last few years (Regan & Sheppard, 1996). Previously, learning in engineering has traditionally been controlled by the instructor and information is presented in a linear lecture format. However, interactive multimedia presents a potential to dramatically alter the learning environment for engineering students by allowing the learner to navigate through databases of media, interpret the information, experiment with it, manipulate it, experience it and build on new knowledge to solve problems.

Changes in Engineering Education

Employers of recent engineering graduates are demanding changes in engineering education (Vest, Palmquist & Zimmerman, 1995; Watson, 1992). Their complaint is that new engineers are being poorly prepared. Today's engineering students will spend almost their entire professional careers in the 21st century coping with challenges that are vastly different from most practicing engineers (Ernst, 1995). Employers feel that graduates may be well-trained in engineering analysis but they lack skills in interdisciplinary problem solving, concurrent engineering teamwork, and communication, all of which are vital for today's intensely competitive industries. Currently, undergraduate engineering students face a different market since there has been a shift from defence to international competition as a major need for engineering employment (Ernst, 1995).

In addition, results cited in a Report on Surveys of Opinions by Engineering Deans and Employers of Engineering Graduates on the First Professional Degree conducted by the National Society of Professional Engineers (1992) indicate that, eight out of ten industry respondents placed a high value on the importance of teamwork in engineering while only one in four felt new graduates were well prepared in this area. In the same report with regards to curriculum, 27% prioritized more engineering design, 62% better communications, and 23% self and social management.

These major issues have caused concern to the engineering community. Consequently during 1989, representatives from academe, industry and government gathered for a conference on Imperatives in Undergraduate Engineering Education to consider revitalizing engineering education to meet the challenges of the twenty-first century. The establishment of the Southeastern University and College Coalition for Engineering Education, SUCCEED was an outcome of this conference. The SUCCEED project Vision Statement reads:

> A major dimension of future American competitiveness lies in the success of our domestic industry's new product innovation and development process. This dictates the need for a new type of engineer to augment the strengths of the traditional engineering specialist being educated today. This new engineer will be a multifaceted technically competent integrator and problem solver who will interface with technical and other specialists in cross-functional team approaches to product innovation, development and production process.
>
> While US engineering specialists are the world's best at the creative aspects of product innovation, existing traditional engineering disciplines fail in their undergraduate educational programs to emphasize the process of bringing these product innovations to successful market introduction. (SUCCEED Vision Statement, 1995).

Presently, it is not clear that the traditional educational framework can continue to meet these demands, so significant effort is currently being focused on developing new curriculum and instructional practice. This effort is exemplified by the National Science Foundation's (NSF) sponsorship of several university coalitions through the SUCCEED project. SUCCEED is one of four coalitions involving more than thirty-two institutions of the NSF Engineering Coalitions Program. Each coalition is funded for a period of five years at an annual rate of $3 million to be matched by the participating institutions. SUCCEED was approved and funded by NSF in the Spring of 1992. SUCCEED's vision for undergraduate engineering education encompasses four major components, one of which is the design and implementation of a fundamentally new and experimental engineering curriculum model called CURRICULUM 21.

A key component to the CURRICULUM 21 model is SUCCEED's emphasis on the interrelationships between the engineering process and the process of engineering. The model consists of three stages: (a) integrated engineering core, (b) engineering design and process core, and (c) functional engineering core. The first learning stage exposes students to the physical sciences, mathematics, life sciences, and humanities within the context of learning and practicing engineering. In the second stage, students learn to integrate design and process into engineering science and applications. In the third stage, students develop their skills in the implementation of product and process in the solution of complex realistic engineering problems.

Demands of technology and society continue to increase the expectations for engineering education (Miller & Cooper, 1995). The use of multimedia-based courseware in engineering education is rapidly gaining popularity in the nineties (Regan & Sheppard, 1996). In order to support these new demands and enhance undergraduate courses with technology, the SUCCEED project has established a “Deliverable Teams” initiative to promote the development of multimedia courseware. Within this initiative groups or teams are funded to develop a “deliverable” product, i.e., a multimedia resource to enhance undergraduate engineering courses.

In addition to the initiatives by government organizations the need for a change is discussed in engineering journals such as ASEE Prism and the Journal of Engineering Education. For example, the discussion has focused on the inadequacy of teaching methods such as lecturing and the introduction of technology delivery systems in undergraduate courses. Over the past several decades the lecture has become the dominant instructional mode for engineering education (Ernst, 1995). New learning theories have prompted concerns about the mismatch of teaching style to learning styles in engineering (Jones, 1989). The mismatch is apparent in the traditional lecture courses delivered by engineering educators. Howell (1996) suggests that a typical lecture to a large class is presented to passive students with no opportunity to reflect on the presentation. Often solution strategies are detailed in a logical step-by-step manner from general principles to an obvious conclusion. There is no structure for students to observe or practice problem solving. The students are expected to integrate concepts and solve assigned problems on their own.

Astin (1993) reported that engineering faculty are substantially more likely than any other faculty to rely on extensive lecturing and much less likely to use class discussion as an instructional technique. They are also less likely to use cooperative learning, are twice as likely to grade on the curve, and less likely to rely on research and term papers, essay exams and student presentations as forms of student assessment. Lonsdale, Mylrea and Ostheimer (1995) also affirm that traditional instruction in engineering courses focus on lecturing which does little to stimulate creative or critical thinking and collaborative interaction. Lonsdale et al., state, “Students in experiencing one large lecture class after another, come to perceive themselves as passive recipients of knowledge. They expect a unidirectional flow of information from faculty and textbooks” (p.187).

According to the meeting of Engineering Deans at Rensselaer in 1995 (documented on the Internet, http://www.rip.edu//dept/newscomm/review/sugust/augo4/d.conf.html)) to discuss the re-engineering of engineering education concluded that there are also general problems with the curriculum, for example :

> A central tenet of any engineering education is that no elegant solution is likely to be found for a problem that lacks a crisp definition. Unfortunately, curricula are complex, often unwieldy creations subject to conflicting demands from the university, from faculty, from students and their parents, and from the industries that employ graduates.

Consequently, one of their recommendations was that breadth in all relevant topics is impossible to achieve. Many traditional curricula assumes that an engineer must know something about every area of the discipline. This may have been the case in the past however, at the Deans meetings they argued that is no longer possible. Another problem is the diversity of the new student population. As engineering programs recruit under represented minorities, a less homogeneous diverse group will result in the need for a more diverse curriculum.

Ernst (1995) recommends that curriculum for all engineering students should be integrated and provide for the development of communication skills and team skills. In addition, it should be practically oriented to allow for “hands-on” laboratory experience so as to integrate theoretical concepts with real life experiences. There are many examples on the Internet that promote these changes to engineering education, for example, the University of California, Irvine (http: //www.reg.uci.edu/UCI/ACADEMICS/aero_ eng.html) whose coursework emphasizes engineering fundamentals and their application to the aerospace field. Laboratory courses provide hands-on experiences with wind tunnel testing etc. Also, the Ohio Northern University (http://www.ono.edu/Admin-offices/admission/Fact.sheet/eng.html) describe the “hands-on” experience in research, development, manufacturing, integration of classroom study with planned supervised work in industry as the highlights of their engineering program.

During the review of literature I found it very difficult to find research regarding changes to engineering education particularly in area of change to undergraduate courses such as statics. Based on an analysis of course outlines published on the Internet there appears to be a shift away from the traditional lecture to a new pedagogy that focuses on experiential courses including laboratory work and design projects (e.g., see the web site http://www.ocasppcp.uc.edu/reprt/met.html). In addition, new statics courses are also incorporating multimedia technology. For example, the ‘Mutimedia Engineering Statics’ (MES) at Georgia Tech and the ‘Multimedia Learning Environment’ (MLE) developed at Virginia Tech.

Perhaps the lack of research is because in the past funding has focused on the technical aspect of engineering rather than teaching (Myers, 1993). To overcome the problem of the lack of emphasis on teaching and consequently educational research, Ernst (1995) recommends that some colleges focus primarily on Ph.D. programs to prepare graduate students for teaching careers and who focus on educational related research. Also, with more recent NSF funding available specifically targeting engineering education, along with many projects such as SUCCEED presently underway, we will soon be witnessing the publication of more teaching related research such as articles from the “Innovator”, a SUCCEED publication (http: //www.che.ufl.edu/SUCCEED/pubs/innovator/innovator. 1.2/succeed3.html).

One engineer who is very active in researching engineering educational issues is Richard Felder. His published longitudinal study of engineering student performance and retention and instructional methods has drawn a great deal of attention to the use of cooperative learning and other instructional methods in order to accommodate a broad spectrum of student learning styles. Felder (1995) found that active and cooperative learning methods facilitated learning, and the development of interpersonal and thinking skills. He explained his instructional practice during the study as being,

> I presented course materials inductively, moving from facts and familiar phenomena to theories and mathematical models as opposed to the usual fundamentals, then applications approach. I always used realistic examples of engineering processes to illustrate basic principles, occasionally provided opportunities for laboratory and plant visits, and several times brought in practicing engineers to describe how they used the methods the students were learning in class. I stressed active learning experiences in class, cutting down on the amount of time I spent lecturing. In homework assignments I

routinely augmented traditional formula substitution problems with open-ended questions and problem formulation exercises. I used extensive cooperative learning, both in and out of class, trying to get the students to teach one and another rather than relying entirely on me as the source of all knowledge ” (Felder, 1995, p.361).

Context for this Study

The context for this study revolves around the ongoing effort of a SUCCEED project at Abbotsford University, where changes are being made to engineering education. Here, an engineering educator was funded by SUCCEED through the “Deliverable Teams” initiative to develop interactive multimedia software for statics. In addition, funds from the teaching and learning center at the university were granted to develop and implement a restructured statics learning environment. The principal goal of his work evolved into the introduction of a new pedagogy that incorporated experiential learning, cooperative learning and interactive multimedia into the new statics learning environment. The engineering professor was given approval by the Colleges of Engineering and Architecture to implement his new statics learning environment in the Fall of 1995 with a pilot group of sophomore architectural students. Since it was a requirement of the SUCCEED project to conduct an evaluation, I was asked to join the project as a research consultant and assist him with the collection and analysis of data for the evaluation.

Purpose of the Study

This naturalistic case study provides a descriptive analysis of the initial phases of the teacher change process (Fullan, 1982) resulting from the implementation of the new statics learning environment. In this case I was not interested in quantifying the very complex process of change but to portray the experiences and perceptions of the study respondents. The purpose of this study was to capture the perceptions of the pedagogical change as viewed by the instructor, students, undergraduate teaching assistant and researchers.

Specifically, I set out to address the following research questions :

1. What are the teacher's intentions for changing his pedagogy ?
2. What are the actual teaching events over the course of the semester ?
3. What are the participants’ (i.e. the instructor, students, undergraduate teaching assistant and researchers) perceptions of the pedagogical change ?

Limitations of the Study

In every study the researcher finds contextual constraints that modify the intended research design. I must, therefore acknowledge that there were some important constraints to my data collection and analysis. The most important was time. The statics course scheduled for the Fall semester consisted of fifteen weeks in duration. Of those fifteen weeks, I spent six weeks in Sydney, Australia. As a result of my father’s terminal illness and death in September, 1995 I was unable to conduct the initial observations and interviews with the instructor and students. A co-researcher, Barbara Lockee (also a doctoral candidate in the Instructional Systems Development program at the time) volunteered to undertake the observations from 29th August until the 12th October. She also interviewed Professor Sparks on 29th September. Rather than being a limitation of this study I feel that Dr. Lockee’s participation added to the triangulation of this study by providing an additional source of data and perspective. While Dr. Lockee’s work was helpful I must concede that I did not experience the new statics learning environment for the entire fall semester.

Since the students did not know me, it was very awkward for us to enter into an interactive process of data collection. For this reason the initial interviews were conducted via electronic mail. However, with the instructor I had been able to establish a professional relationship during the prior twelve months and was able to commence interacting immediately upon my return to the site. This process continued on a bi-weekly basis until the 17th November, 1995 when divergent views occurred about the instructor’s pedagogy resulting from differences in definitions and terminology. After this date, the instructor’s lack of response prevented further data collection and analysis (see Chapter 2 for a detailed description of the interactions that occurred). He officially withdrew from the study in April, 1996. This was a limitation of the study because it affected the collection and analysis of data regarding the instructor’s perception of the teacher change process. Therefore, I was unable to verify my interpretations with the instructor. Fortunately, interactions with the students continued via electronic mail and face-to-face interviews throughout the remaining weeks of the semester. The limitation here, however, was that only 6 out of 20 students volunteered to participate in the interviews.

Organization of the Dissertation

The study is organized into five major chapters. The first chapter presents a review of literature. The remaining sections of this dissertation are as follows:

Chapter 2 : Methodology

This chapter provides a rationale and discussion of a naturalistic inquiry approach. It includes a description of the participants, sampling techniques, data sources, collection and analysis procedures for the descriptive case study. In addition, the interpretative interactions with study participants during data analysis are discussed as well as the researchers’ stance. Issues regarding the trustworthiness of the study are also addressed.

Chapter 3 : The New Statics Learning Environment Described

This chapter describes the historical information leading up to the restructuring of the statics learning environment, and specifically focuses on Professor Sparks' intentions for its design. Also provided are a description of the main components of the new statics learning environment which include an experiential model of learning and the pedagogical tools of cooperative learning and interactive multimedia.

Chapter 4 : The New Statics Learning Environment Enacted

This chapter describes the actual implementation of Professor Sparks’ new experiential teaching/learning model and the pedagogical tools of cooperative learning and interactive multimedia into the new statics learning environment. In addition, Professor Sparks, the students, the undergraduate teaching assistant, and the researchers perceptions of the change are presented.

Chapter 5 : Conclusions

This chapter presents the major issues that emerged from the study relating to teacher change process, offers connection to theory, and poses final comments and conclusions. Recommendations for future research are also presented.

Chapter 2

Methodology

Rationale

The methodology for this case study is a naturalistic mode of inquiry developed by Lincoln and Guba (1985). In Erlandson, Harris, Skipper and Allen (1995), " Doing Naturalistic Inquiry ", Lincoln refers to this model as constructivist inquiry (p.ix). This methodology was chosen because it is in accordance with the instructor's and researcher's theoretical perspective of constructive learning. It is also compatible with the notion of multiple realities which is discussed later in the researcher's frame of reference. In essence, naturalistic inquiry provides a framework for examining the process of change and the perceptions of those that experienced Professor Sparks' pedagogical change. Specifically, it is the intention of the researcher to provide a case study which describes the respondents experiences in the restructured statics learning environment.

Case Study Format

A case study is defined as, "the study of the particularity and complexity of a single case, coming to understand its activity within certain circumstances " (Stake, 1995, p.xi). A case can be an individual or a group (Patton, 1990). This study is a case of an educator who redesigned a new learning environment to incorporate an experiential learning/teaching model and the pedagogical tools of cooperative learning and interactive multimedia. Because of the theoretical framework supporting this study the perspectives of the students, undergraduate teaching assistant , and researchers as well as the instructor are central in the construction of the case. These perceptions were accessed through the analysis of observations, questionnaires, interview data and electronic mail messages.

Participants

The major participants in this research included:

1. Instructor, Professor Sparks. The central participant of this study is an award winning engineering professor. A complete profile of the instructor is presented in Chapter 3.
2. Undergraduate teaching assistant. Mary, who was in the process of completing a double major in engineering and architecture. She attended each class and her duties included the assessment of the homework problems (no further data is available for Mary).
3. Sophomore architectural students enrolled in the mandatory statics course. Sampling process and student profiles are discussed below.
   Pseudonyms are used in the study to protect the identity of the participants.
4. Researchers (Tina Bavaro & Dr. Barbara Lockee). The researchers are from the Instructional Systems Development program which is part of the Department of Teaching and Learning). The stances of the researchers are available later in this chapter.

Student Sampling for Interviews

It was my intent to employ purposive sampling strategies in order to select a range of students to be interviewed. According to Patton (1990), purposive sampling is described as a method of selecting information-rich cases whose study will bring to light the questions under investigation. Patton (1990), describes several strategies for purposive sampling. Of the strategies listed criterion sampling is the most appropriate for this study because it involved choosing individuals that met specific criteria. In compliance with the institution's human subject's policies, an informational consent questionnaire (see Appendix A), was distributed to all students. Students were asked to rate themselves on the following criteria using a scale of 1 (Low) to 5 (High). The questionnaire identified the following criteria:

1. Familiarity with collaborative learning.
2. Familiarity with computer technology.
3. Familiarity with experiential learning.
4. Familiarity with the concept of forces.
5. Familiarity with algebra and trigonometry.

Students were classified as "Low" familiarity if they scored themselves with a 1 or 2, "Medium" familiarity was based on a score of 3 and "High" familiarity was a score of 4 or 5.

The selection process for the pilot group began on Tuesday, 22nd August, 1995 when a population of 135 sophomore students enrolled for the fall semester Statics (a mandatory course for architectural students) attended a demonstration of the interactive multimedia software by Professor Sparks. At the end of the meeting twenty-one students volunteered to participate in the experimental, new statics learning environment. The class consisted of 3 females and 18 males. By mid-semester three male students failed to attend classes and consequently were considered by Professor Sparks to have dropped the course.

Sampling for this study began with the initial population of students in the class. All indicated a willingness to participate in the observations, except for one of the female students who chose not to participate in the study. Ten students agreed to be interviewed from the questionnaire, however only six students responded to the mid-semester electronic mail interviews. The same six students also participated in the final face-to-face interviews. At this point of time, purposive sampling was not achieved and participating students represented a convenience sample. However the student volunteers did present a range of students in terms of the original questionnaire criteria. Consequently, in order to best describe these volunteers for the interviews student profiles were developed (see Appendix B).

Setting

Abbotsford University is a publicly supported, comprehensive, land grant university located in southeastern United States. It is considered to be one of the leading research institutions in North America. The university has nine colleges, one of which is Engineering. The college claims that it is,

> Consistently rated as a premier institution by its peers in surveys of the nation's engineering school deans by the US News & World Report. The same magazine ranked our undergraduate program in the top 20 for the quality of our undergraduate program. In addition, Money magazine, investigating what it considered to be the best value in education for the

dollar spent, scored the University as one of the top ten science and technology schools in value rankings. The graduate program is ranked 25th in terms of reputation as reported by its peers, and 18th by practicing engineers (Internet, July, 1996).

As stated earlier this college is part of the SUCCEED coalition consisting of nine southeastern university colleges committed to the revitalization of undergraduate engineering education for the 21st century.

The new statics learning environment was scheduled in a civil engineering computer laboratory at Abbotsford University. Students and the instructor accessed the interactive multimedia software through IBM 486 and IBM compatible computers. This location was chosen by the instructor primarily for its computer hardware resources. The interactive multimedia software was loaded onto the civil engineering server. Students worked either individually, in pairs or in groups of three. As a consequence not every student used the interactive multimedia software.

The electronic classroom consisted of twenty IBM and IBM compatible computers, situated in three linear rows on each side of the room (see Figure 2.1). There was approximately 12’’ of desk space between each computer. The computers were not equipped with document holders. All the computers faced the front of the classroom. The height of the computers were approximately 20” at the desk level. A white board, large screen and overhead projector were also situated at the front of the room. The two printers were situated in the right corner in the back of the room.

Figure 2.1 The electronic classroom setting for this study.

Data Sources and Collection Procedures

Primary sources of data included the human instrument, electronic mail, and face-to-face interviews, non-participant observations, questionnaires, and a review of documents. A brief overview of the research questions and the data sources are shown in Table 1 see page 17.

Data sources and collection procedures for this study are outlined in Table 2 see page 18. The primary purpose of gathering data is to construct reality in ways that are consistent and compatible with the respondents from the setting (Erlandson et al., 1995). Data collection in the site officially commenced on the 22nd August, 1995 and ended in April, 1996 (see Appendix C for a time line of the events of this research).

Table 1.
Data Source and Research Questions

Data Source	Research Questions
Human Instrument	What were the participants' perceptions of the pedagogical change ?
Observations Non participant observer in the setting	What were the actual teaching events over the course of the semester ?
Interviews Electronic Mail Face to Face Questionnaires Professor Sparks Questionnaire Researcher's Questionnaire	What were the participants' perceptions of the pedagogical change ? What were the teacher's intentions for changing his pedagogy?
Document Review Minute Papers Syllabuses Papers written by Professor Sparks	What were the actual teaching events over the course of the semester ? What were the participants' perceptions of the pedagogical change ?
Artifacts Photographs of Professor Sparks	Photographs of the instructor were used as prompts in interviews to ascertain : What were the participants' perceptions of the pedagogical change ?

Table 2
Data Sources and Collection Procedures.

Data Source	Who	How	When
Human Instrument	The researcher. Researcher's Journal, and Audit Trail.	Interpreting the data, coding and analyzing the data.	Throughout the study. The researcher documented all the critical events that occur during the study, see Appendix C.
Observations	Researcher observed the nature of teaching & learning in the restructured statics learning environment, particularly the instructor's pedagogy.	Non-participant observer. Field Notes. Observation Plan.	Throughout the study, two afternoons a week for approximately 1 1/2 hours. A total of 22.5 hours of observations.
Interviews	Instructor - Professor Sparks.	Interview Guides, see Appendix D. All face to face interviews were audio taped, and transcribed by the researcher.	Interviews with the instructor occurred every other week, communication was primarily through e-mail, with also face-to-face interviews on : 29th September, 21st October 17th November, 15th December, 1995. 15th April , 1996 Meeting with my advisor and Professor Sparks 17th April, 1996.
	Students	Via electronic mail. and Face to Face. Interview Guides, see Appendix D.	Students were interviewed during Phase 1 (mid-term) via e-mail, and Phase 2 face to face interviews occurred during (1st December, 1995). Further electronic mail correspondence occurred throughout December until the end of the semester.
	Undergraduate teaching assistant.	Interview Guides, see Appendix D.	1st December, 1995.
Bavaro Questionnaire	Students.	Appendix E.	12th December, 1995.
Sparks Questionnaire	Students.	Appendix F.	5th December, 1995.
Documents			
Minute papers	Students	Submitted to the instructor.	Minute papers were completed at the end of each lesson. I reviewed and summarized the minute papers responses bi-weekly.
Listserv comments.		Communication with the instructor and students.	Limited communication between the instructor and students occurred on the listserv.
Syllabuses	Traditional Statics New Statics Syllabus.	Appendix J	
Published Papers	Professor Sparks.		
Photographs	Students and instructor.	Taken during the final class.	Were used as prompts during the interview with the instructor.

The Human Instrument

In a naturalistic inquiry the researcher is considered the prime instrument for the study (Patton, 1990). I functioned in this study as the human research instrument because of my interpretations, coding, analysis and reporting of the data. A full description of the data analysis procedure employed for this study is discussed later in this chapter. My stance as a researcher and educator is described at the end of this chapter.

Observations

Observations occurred twice weekly for approximately one and half hours in duration for fifteen weeks of the semester. Dr. Lockee conducted the first six weeks of observations and I completed the remaining nine weeks of the semester. A total of 22 class sessions, and a 33 hours of classroom interaction were observed. We documented observations in the form of general field notes, and undertook the role of non-participant observer in the setting. Since it was impossible to observe and record everything in the setting, I decided to develop an observation plan (see Table 3) adapted from Erlandson et al. (1995). The observation plan firstly focused on the setting and participants and then on Professor Sparks pedagogy. However, as previously mentioned since I was absent from the site during the first 6 weeks of observations phase 1 was not implemented. Therefore, the data to provide an in-depth description of the participants was not collected.

As previously mentioned Dr. Lockee volunteered to collect the data on my behalf. Consequently, I gave her a copy of my research proposal before I left the US. After my departure from the site Dr. Lockee met with my adviser, Dr. Magliaro to discuss the procedures for the observations and develop questions for the first interview with Professor Sparks. Dr. Lockee followed a general procedure of documenting what was happening in the learning environment, these notes were submitted to Dr. Magliaro for feedback. Upon my return to the site, I met with Dr. Lockee and Dr. Magliaro and was briefed on the research process conducted during my absence. I decided to focus on phase 2 of the observation plan, because of the lack of time to start on phase 1.

Table 3.
Observation Plan For This Study

Phase 1	Focused on the initial entry into the site August 1995 such as: • The setting : description of the physical environment. • The participants : description of all the participants.
Phase 2	Focused on the nature of teaching and learning particularly the instructional and assessment strategies. Observations also included: • Experiential learning. • Cooperative learning. • Use of technology in the restructured statics learning environment.

Interviews

Interviews consisted of written dialogue via electronic mail and verbal, face to face interactions between the researcher and study respondents (see Appendix D for semi-structured interview guides). All face to face interviews were audio taped. This type of data helped to capture the respondent's perspective of the pedagogical tools in the new statics learning environment (Erlandson et al., 1995).

The instructor, students and undergraduate teaching assistant were interviewed throughout the study. Professor Sparks was interviewed on 5 occasions for approximately one hour each session. Photographs taken during the final observations were used as prompts during the last interview with Professor Sparks. I conducted the first phase of student interviews (after the mid-term exams) via the internet and electronic mail. Of the ten messages sent, six students responded, two students had left the course and two messages returned undelivered. The second phase of interviews took place at the end of the semester and were conducted face to face with five students and the undergraduate assistant for approximately one hour in duration. One other student unable to attend the meeting was interviewed via electronic mail.

Questionnaires

Questionnaires served as another source of data. Specifically, two questionnaires were developed and administered in this study with the purpose of collecting data about the interactive multimedia software. Because of my role as a research consultant with the Teaching and Learning Center project I developed and administered one of the interactive multimedia questionnaires to the 6 student who participated in the interviews (see Appendix E). The other was developed and administered by Professor Sparks to all the students during class on the 5th December (see Appendix F).

Documents

Documentation included minute papers which were a key source of data. Professor Sparks adapted the notion of minute papers from Charles Schwarts, a Professor of Physics from the University of California, Berkeley, USA. Sparks asked all the students to comment about their learning at the end of every class, i.e. two classes per week with approximately 17 minute papers collected per session (see Appendix G for an exemplar used by Professor Sparks). Other documents included statics syllabus outlines from the College of Engineering and conference papers available on the internet that were written by Professor Sparks. Another resource on the internet was the SUCCEED home page. Photographs taken during the last class on the 5th December were used as prompts for discussions when I interviewed Professor Sparks on 15th December, 1995.

Researcher's Journal

This was a type of a informal diary that contained the researcher's schedule, insights, reason for methodological decisions and events that occurred throughout the study. These notes were summarized and displayed as a flow chart in Appendix C.

Data Analysis Procedures

There is not a precise point in this study at which analysis began and data collection ended. According to Lincoln and Guba (1985), the analysis of the data involves taking constructions gathered from the context and restructuring them into meaningful wholes. Data collection and analysis evolved into an interactive process that occurred during concurrent and integrated phases that built upon one another during the study. The first collection of data yielded an initial analysis in August and September of themes relating to the role of the instructor, the role of experiential and collaborative learning, and the role of the technology in the new statics learning environment. More focused data collection occurred during late October, regarding the teacher change process and the perceptions of the study respondents about the change process which led to a further analysis in November and December. Even though the course had concluded in December 1995 and observations ceased on the 5th December. I did not receive the data from Professor Sparks' interactive multimedia questionnaire data until April, 1996.

As the primary researcher, I continually returned to the site during each phase of data collection to present a summary of the data and to discuss it with the respondents. In addition, refer to Table 4 for a detailed description of the interactions between the researcher and the respondents of the study which influenced the data analysis.

Table 4 .
Interactions Between the Researcher and the Respondents.

Time Frame	Detailed Description
August , 1995	Commencement of study, observations by Bavaro and Lockee. I left the site on the 26th August.
September	Continuation of observations by Lockee. Interview conducted with Professor Sparks on the 29th September.
October	Continuation of observations by Lockee until 12th October. I conducted a face to face interview with the Professor Sparks on the 20th October.
November	At the following meeting on the 3rd November. I provided Professor Sparks with a summary of student comments from the minute papers. Electronic mail interviews were conducted with students on the 3rd November. Electronic mail correspondence with Professor Sparks. This was to seek clarification regarding his role in the restructured statics learning environment. Electronic mail correspondence with graduate assistant, no response received. ***During the initial stages of data analysis divergent views began to emerge about the instructor's pedagogy.*** Conducted a face to face interview with Professor Sparks on the 17th November and provided him with the student responses to the interview questionnaire and also a summary of his instructional and assessment strategies (complied from the observational data collected by Lockee & Bavaro). Dr. Lockee had verified the data in a peer debriefing session before my meeting with Professor Sparks. Electronic mail correspondence with Professor Sparks to seek clarification about comments from the two previous interviews. No written response received. Electronic mail interview sent to the graduate assistants regarding the interactive multimedia software. No response received.
	The 17th Nov. was the demise of the interactive process of data collection and analysis with Professor Sparks . At this time he postponed meetings preventing the collection of further data.
December	Three meetings canceled by Professor Sparks. Face to face interviews with 5 students and the undergraduate assistant on 1st and 6th December. Electronic mail interview with a student who could not attend the face to face interview. Electronic mail interactive multimedia questionnaires sent to the students on the 6th December. Face to face interview with Professor Sparks on the 15th December.
April, 1996	***Withdrawal of Professor Sparks from the research process.***

The procedures for analyzing the data were as follows, in August 1995 and continued until 4th June, 1996. Data analysis involved a twofold approach. The first stage was the data analysis at the research site during the collection of data. The second aspect involved the data analysis away from the site following the data collection. The second stage was conducted between site visits prior, to as well as after, the completion of data collection.

I commenced the analysis by listening to the tapes and transcribing the interview data and reading the observational field notes and the minute paper responses. The observational data was then summarized and displayed as a chart in Appendix H. This chart was organized into the classroom procedures that Sparks intended and implemented (e.g., warm up problems, activities and minute papers) in the new statics learning environment. The students' perceptions of the class (i.e., minute paper responses) were also displayed in the chart so that the reader would have a clearer picture of what was happening in the class from their perspective.

During the analysis of the data I chose to "chunk" units of data consisting of a few words, sentences or paragraphs and labeled according to the role of the instructor, experiential learning, cooperative and the role of the interactive technology. As these chunks reoccurred in the data they were organized into categories relating to the three pedagogical change foci intended and enacted by Professor Sparks. This data is also documented in Appendices of this document and are displayed as charts. A further analysis occurred when I identified sub-categories from the charts (these sub-categories are reported in Chapter 4).

As a classroom practitioner I am interested in process of teacher change and therefore chose to focus on the issues relating to the change process in this study. Consequently, this influenced the final analysis of the data. The three major issues that resulted from the continual interactive method of analysis were the frustrations of the teacher change process experienced by the study respondents, the issue introducing three new innovations simultaneously into the new statics learning environment and the difficulties of Sparks paradigm shift in pedagogy. These issues will be explained further in Chapters 3, 4 and 5. Tools such as MS Word was used to manage the process of data analysis. The software assisted me in the management and co-ordination of all the data sources.

Trustworthiness of the Study

When establishing the trustworthiness of this study I incorporated triangulation Erlandson (1995). Triangulation is the use of different and multiple sources of data from the researchers observations, interviews with the instructor, the students and the undergraduate teaching assistant, documents such as the minute papers, electronic mail correspondence, articles and home pages on the internet, and my researchers journal containing an audit trail in order to enhance the credibility of this study, (see Figure 2.2).

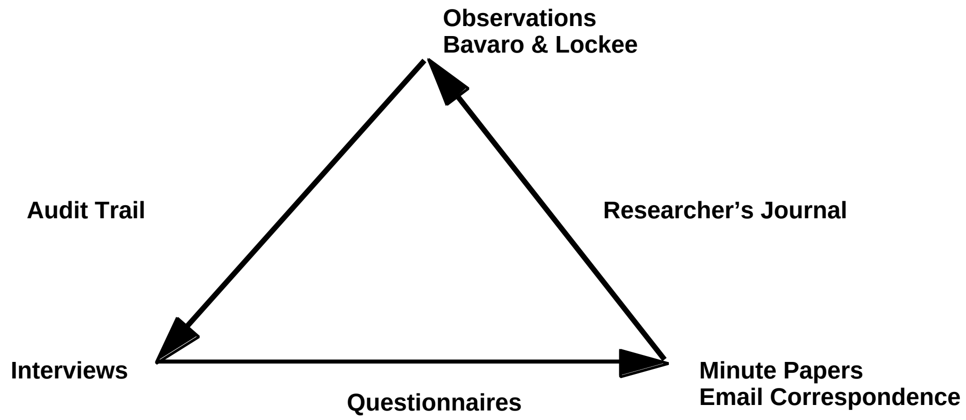

Figure 2.2 Triangulation of data for this study.

According to Erlandson et al., (1995),

> " The degree of convergence attained through triangulation suggests a standard for evaluating naturalistic studies. In other words, the greater the convergence attained through the triangulation of multiple data sources, the greater the confidence in the observed findings. The convergence attained in this manner, however, never results in data reduction but in an expansion of meaning through overlapping, compatible constructions emanating from different vantage points." (Erlandson et al., 1995, p.139).

Specifically, the observations by the researchers provided an overview of what was generally occurring in the new statics learning environment. The observational data were compared to the student minute paper responses. Then, these data were compared with the interview data (i.e., Sparks' perceptions, student's perceptions from the electronic mail and face-to-face interviews, and also Mary's interview data) in order to obtain a clearer picture and insight into the new statics learning environment. This constant comparative method provided a degree of congruence of data regarding Sparks' new pedagogical tools.

Naturalistic inquiry presents an interpretivist paradigm for research that is quite different from the traditional, positivist (quantitative) paradigm (Greene, 1994). Consequently, a different set of assumptions concerning reality, epistemology and generalizability guided my research. Lincoln and Guba (1985), have identified the following standards for naturalistic inquiry. They include authenticity criteria such as, truth value, applicability, neutrality and consistency to establish the "trustworthiness" of a study. In relation to this study I provided for truth value through credibility (in lieu of internal validity), applicability through transferability (in lieu of generalizability and external validity), neutrality through confirmability (in lieu of objectivity), and consistency through dependability (in lieu of reliability). These criteria and their relationship to traditional, positivist research are summarized in Table 5 .

Table 5.
A Comparison of Traditional Researchand Naturalistic Inquiry (Lincoln & Guba, 1985).

Criteria	Traditional	Naturalistic	Techniques	Products
Truth Value	Internal Validity	Credibility	Prolonged Engagement, Observations, Triangulation, Peer debriefing, Member Checks.	Researcher's Journal (where the researcher records information about themselves e.g. schedule, insights, reasons for methodological decisions).
Applicability	External Validity	Transferability	Thick Description, Purposive Sampling.	Researcher's Journal
Neutrality	Objectivity	Confirmability	Audit Trail.	Researcher's Journal.
Consistency	Reliability	Dependability	Audit Trail.	Researcher's Journal.

Credibility (in lieu of Internal Validity)

Member checking was a technique employed to ensure the credibility of this study. I continually asked the respondents and co-researcher, Dr. Lockee to read and confirm the interpretations and conclusions from the data. While this process continued throughout the study with the students and my co-researcher, I was unsuccessful in clarifying discrepancies in the data such as the clarification of definitions because of Professor Sparks' withdrawal from the study. Documents are another data source that support the credibility of this study by providing context rich materials which serve as a background to support data analysis and interpretation.

Peer debriefing is another strategy utilized to develop a credible study. According to Erlandson et al. (1995), peer debriefing transpires when the researcher seeks out professional people not related to the context of the study but who have some general understanding of the study. While the researcher discusses her/his ideas and concerns about the study, the peer listens and asks probing questions, the discussion is then documented. Peer debriefing occurred during informal discussions with Dr. Glenda Scales and Dr. Barbara Lockee throughout the study. Both Dr. Scales and Dr. Lockee are graduates from the Instructional Systems Development Program, from the Department of Teaching and Learning. As part of their doctoral studies both have had considerable experience with technology and qualitative research, in particular, naturalistic inquiry. They provided me with a sounding board in order to debrief during the research process.

Transferability (in lieu of External Validity)

Validity has little meaning when there are multiple realities which exist only in people's minds (Erlandson et al., 1995). Peoples actions are also indicators of meaning. The findings of this study cannot be generalized. However, they may be transferable that is, to the extent to which the various dimensions of this study can be applied to other contexts or with other respondents. Erlandson et al., recommends two strategies to facilitate the transferability of a study. First, a "thick description" of data brings the reader vicariously into the setting the researcher is describing and therefore paves the way for shared constructions. Second, purposive sampling provides information rich cases from which to study. To the extent possible I attempted to incorporate the first and second strategy into this study.

It is important to note that part of the responsibility or obligation for demonstrating transferability belongs to those who would apply it to the receiving context (Guba & Lincoln, 1989). This is in contrast to a traditional study where it is the responsibility of the researcher to ensure the findings can be generalized to the population.

Confirmability (in lieu of Objectivity)

Objectivity is usually a goal of traditional research, however no methodology can be totally separated from those who have created and selected it (Lincoln & Guba, 1985). This study ensured confirmability of the data through an audit trail and the articulation of the stances of the researchers. This means that the data can be traced to the original source and the logic used to assemble the interpretations is explicit to the reader.

Dependability (in lieu of Reliability).

The traditional notion of reliability is problematic when dealing with naturalistic inquiry, not only due to the nature of the data, but also because natural events cannot be reproduced or replicated (Erlandson et al., 1995). Reliability may not be assured but dependability can be assured through an audit trail where the researcher has documented and maintained records throughout the study. An audit trail enhances the trustworthiness of the study through the external judgment of an auditor (Erlandson, et al., 1995). In this case my advisor, Dr. S. Magliaro acted as an external auditor at the end of the study. She determined the procedures of the data analysis and the writing of this case study.

The audit trail consisted of:

1. Raw data, interview guides, observation notes, original documents.
2. Data reduction and analysis, peer debriefing notes with other graduate students, data reconstruction (audio-taped interviews with Dr. Magliaro).
3. Notes from the researcher's journal, researcher's decisions and critical events.

Ethical Considerations

These are at the forefront of the researcher’s mind particularly a respect for the people under study. A consent form was distributed to all respondents of the study seeking their permission and ensuring complete confidentiality (see Appendix A). As Taylor and Bogdan (1984), suggest the intentions and purpose of the inquiry were discussed with all respondents throughout the study and pseudonyms were used in the writing of this case study. A major ethical consideration for this study was that this dissertation presented a fair description of Professor Sparks’ intent and enactment of his new statics learning environment.

Researchers’ Frame of Reference

Since the researcher is the prime instrument in a naturalistic inquiry (Patton, 1990) the researcher must report any personal and professional information that may affect data collection, analysis and interpretation (either negatively or positively in the minds of users of the findings). This section reflects the background and stance of myself and Dr. Lockee.

M. Tina Bavaro

Background. As the researcher, I am a third-year doctoral candidate from the College of Education, who majored in Instructional Systems Development from the division of Teaching and Learning. I am an Australian citizen and bring with me fifteen years of teaching and curriculum consultancy experiences from the field of Technology Education. I have completed a Bachelor and Masters of Education degree, the latter with a major in Curriculum Studies.

Prior to commencing my doctoral degree in the United States of America, I was employed as a Senior Curriculum Advisor for the Department of Education, where I provided advice to the Director of Curriculum and the Minister of Education regarding the implementation for the New South Wales' mandatory technology curriculum, Design & Technology and all other curriculum in the Technological and Applied Studies Key Area of Learning. This included Industrial Arts and Engineering subjects. I also provided advice to the Australian Academy of Design regarding reforms to engineering education in Australia.

During Fall 1994 I met and consulted with Professor Sparks on a weekly basis to develop workshops for the formative evaluation of the interactive multimedia software that he was developing (see Appendix I -Historical Background to this Study, about finding and gaining access to a site). These meetings later evolved into a major project for my instructional design class and thus further evolved into a doctoral dissertation. During the semester, discussions regarding the design of the interactive multimedia software progressed towards a new statics learning environment rather than the original focus on the software.

During Fall 1995 Professor Sparks employed me as a research consultant funded via a grant from the Center for Teaching and Learning at Abbotsford University. He received this grant in order to evaluate the implementation of the restructured statics learning environment. Professor Sparks aimed to introduce and evaluate a workshop environment in the subject area of statics that combined hands-on experiments with interactive multimedia within the framework of experiential and collaborative learning. The workshop environment was to be introduced and evaluated in the fall of 1995 (Sparks, 1995).

This grant placed me in a dual and sometimes conflicting role: first, one of an evaluator, and second, one of a doctoral researcher (see Appendix C for a flow chart of the critical events of this study). Upon my return to the site and again immersed in the setting, it appeared that it was too early to engage in a summative evaluative effort. Ethically, I felt that I could not conduct an evaluation of the statics learning environment because the new statics learning environment was only in the initial phases implementation (Fullan, 1982). This dilemma consequently prompted a direction change for this study. I chose to separate the two roles and pursue a study that specifically described the learning environment from the perspectives of those that experienced it, rather than an evaluation study, that placed a value judgment on the effectiveness of the restructured statics learning environment. A detailed theoretical summary of my role in this study is explained in Table 6.

Table 6.
(Bavaro) Researcher’s Role, Adapted from Patton (1990).

Primary dimensions used to describe the variation in approaches to research observation.	**Description**
Role of the researcher.	Doctoral researcher : This role involved collecting data that described the experiences of participants from the new learning environment. Evaluator : This role involved evaluating the restructured statics course. I was paid $2,000 to provide Professor Sparks with data about the restructured statics learning environment.
Portrayal of the researcher to others.	During the summer of 1995 I was introduced as a Ph.D. student conducting research about the implementation of the interactive multimedia software to Professor Sparks’ team of graduate assistants. I was not introduced to the class until after the mid-term examination (last week of October, 1995). However, informally, whilst in the site I introduced myself as a educational researcher and that my role was to collect data about the new statics learning environment .
Focus of the Observations	Firstly, the observations provided a broad picture of what was actually happening. Then as the semester progressed the observations focused more on the instructor’s instructional practice and his role in the learning environment.
Duration of the research.	For the doctoral dissertation, my entry into the site commenced on the 22nd August, 1995 and data collection continued for a total of 15 weeks until the end of the semester, December.

Stance on teaching and learning. My beliefs about teaching and learning can be best summarized by the following statement,

> As an educator, I believe that the learning and teaching process should be respectful of the needs and experiences of learners. Learning should be student centered and focus on their construction of new knowledge through collaborative, experiential and inquiry based activities. The learner and teacher become partners in the learning process, where they together develop goals and objectives for learning.

The above statement dramatically alters the nature of the traditional instruction if one makes the accepts the view of learning, that the learner is a constructor of knowledge (Mayer, 1992). Therefore, the role of the teacher becomes one of assisting learner during the shared construction of meaning and new knowledge (Vygotsky, 1978). Teaching is a vehicle through which the interactions of social and cultural environment are internalized by the learner. Therefore, the creation of the learning environment becomes more significant than the instructional sequence of content.

A socio-cultural perspective of learning represents a shift from a traditional teacher-centered instruction and places greater emphasis on the learner. Students undertake a participatory and collaborative role rather than being a passive recipient to information from the teacher. Furthermore, it changes the role of a teacher to one of a facilitator (Gallimore & Tharp, 1993). I also believe that it is the instructor's responsibility to create tasks and a learning environment that assist learning. As an instructional technologist, I believe that technology such as interactive multimedia is a resource or tool that is utilized in the learning environment. As a researcher, I also give credence to the notion of " multiple realities" or from which individuals may view the world with the possibility of many meanings or multiple realities for any event or concept.

Dr. Barbara Lockee

Background. Dr. Lockee completed her doctorate in 1996 from the College of Education, she also majored in Instructional Systems Development from the division of Teaching and Learning. In 1991 she graduated with a Masters of Arts degree, majoring in Instructional Technology from Appalachian State University. She also completed her undergraduate degree a Bachelor of Arts at the same university majoring in Communications Media.

Dr. Lockee is presently employed as an Evaluation Coordinator for Distance Learning at the Office of Educational Technologies at Virginia Polytechnic Institute and State University (VPI). Her professional experience includes the role of an instructor at Faculty Development Institute Workshops at VPI and at Appalachian State University.

Stance on teaching and learning. In an interview 17th December, Dr. Lockee stated that:

> As a secondary data collector, it is necessary for me to disclose my ideas about how learning occurs, specifically how it occurs using the interactive multimedia software and collaborative, experiential learning instructional methods. One of the reasons I agreed to participate in the observation process of this study is that I, too, concur that learning is effectively facilitated when the instructor provides an environment that is motivating, relevant, and socially interactive. I was anxious to see a classroom where these strategies were to be implemented.

Motivation is a necessary factor in the learning process. Different students are motivated by different things, but collectively, students can be motivated by an instructor who is encouraging, knowledgeable, and willing to assist in the learning process. Also, students typically appreciate an instructor who shows respect for them and their ideas. Relevance of content is also very important to promote learning. When the topic is tied to the learner's frame of reference, the concept is more readily understood.

Chapter 3

The New Statics Learning Environment Described

This chapter describes the historical information leading up to the restructuring of the new statics learning environment with a primary focus on Professor Sparks' intentions for its design. First, the traditional statics learning environment is outlined. Next, the main components of the new learning environment are discussed. They include an experiential model of teaching/learning and the new pedagogical tools of cooperative learning and interactive multimedia. Then, Professor Sparks is profiled.

The Traditional Statics Learning Environment

Curriculum

Fundamentally, statics is the study of forces on an immovable body or bodies in equilibrium. The statics curriculum is overseen by the College of Engineering. It is the first course in a sequence of courses from the Engineering Science & Mechanics Department to develop fundamental knowledge required by different engineering departments and students in the College of Architecture.

For engineering students, the statics course content provides more breadth of content and included, vector mechanics of forces, mass, space, time, SI units, equilibrium in three dimensions, free body diagrams, moments, couples, resultants, distributed forces, centroids, shear and moment in beams, friction, 2D motion, projectiles, normal and tangential coordinates, polar coordinates, relative motion, constrained motion and Newton’s Second Law.

For the architects, the target group for this study, the course is aimed at helping students to pass state licensing examinations and to acquaint them with the language and methods used by structural engineers. Course content examines the types of loads applied to architectural and engineering structures, methods of calculations of structural response, and design and analysis for simple components.

Pedagogy

Traditionally, the pedagogy for statics is characterized by structured presentations of curriculum materials through lecture and demonstrations. In essence, the learner is considered a recipient and processor of information dispensed by the teacher (Mayer, 1992). This is also characteristic of the receptive-accrual view of learning where, “learning is simply a function of receptivity to information that is accrued by the learners without modification ” (Anderson, 1989, p. 86).

Given the traditional statics learning environment is predominately lecture based and content and text book driven, there is little interaction amongst the students. The teacher provides students with definitions, procedures and principles for solving text book problems related to structures. These are characteristics thought to be in a teacher directed learning environment. During informal discussions with Professor Sparks in the fall 1994, he mentioned that it was commonplace for many students to memorize formulas and work through statics problems without understanding the underlying fundamental concepts.

Syllabus

The traditional statics syllabus for the engineers states that at the conclusion of the course, students will be able to:

1. Work with force vectors, moments, couples, and resultants in two and three dimensions.
2. Draw appropriate free body diagrams and analyze the external equilibrium conditional of two and three dimensional bodies.
3. Solve for the internal forces in simple trusses, frames and machines.
4. Analyze distributed loads and the resulting internal beams.
5. Determine the relationships among position, velocity, and acceleration for particle motion in two dimensions.
6. Analyze the kinetics of particle motion according to Newton's Second Law.

The traditional statics syllabus for the architects (1995) contained a week-by-week description of a content-oriented curriculum driven by the text, "Statics and Strength of Materials", by Fa-Hwa Cheng (1985). Grades were to be calculated on student performance in homework, quizzes, three open book class tests and a final examination. Resources such as visual aids, illustrations and films were also listed on the syllabus.

The New Statics Learning Environment

The Impetus for Change

Presently, approximately forty percent of students do not pass statics on their first attempt at Abbotsford University. This statistic along with funding from NSF and an extensive review of educational literature, provided Professor Sparks with the impetus to change the statics learning environment. He explains, " I'd like to see statics become a gateway course to engineering, not a deterrent."

Deriving from the broader issues facing engineering education in the nineties, Sparks discussed the main changes to his curriculum as providing depth rather than breadth of statics knowledge. Moreover, he wanted to offer opportunities for practical experiences in order to link or connect complex theoretical concepts to real life experiences and engage students in active learning.

However, regarding the engineering curriculum Sparks described the change as a slow process, he said,

> The college has a curriculum... that changes very, very slowly... The original statics course, is very close to what I had forty years ago, it is just appalling... I used to just beat my head against the wall, trying to help them make the change, because if you want to have an example of how not to teach statics, how it is taught to engineers it is a perfect example.

As previously mentioned from the deliverable teams component of SUCCEED, funding was obtained from the National Science Foundation (NSF) for Abbotsford University to develop a new mode of delivering fundamental engineering courses through interactive multimedia. Concurrent with the funding opportunities, Professor Sparks embarked on a review of educational literature to gather new information regarding teaching and learning methods and interactive multimedia technologies. His readings focused on the work of Piaget (1954), Kolb (1984), Vygotsky (1978), Felder (1994), Johnson, Maruyama, Johnson, Nelson and Skon (1981), and Laws (1991), all of which had a profound influence on the design of the new statics learning environment. Sparks said,

> Our guiding principle in the design of the interactive multimedia software is constructivism (Piaget, 1954). The basic idea is that knowledge must be constructed by the learner; it cannot be supplied by the teacher. This implies that we are all responsible for our own learning; the teacher is responsible

for creating an effective learning environment. In addition to important elements of learning, drawn from the literature (Sparks 1994), we have adopted experiential learning (Kolb, 1984) to guide the design of the interactive multimedia software .

From Vygtosky (1978) and Felder (1994) Sparks adopted the notion of collaborative learning and focused on Johnson et al., (1981) model of cooperative learning. Kolb's (1984) work encouraged Sparks to consider the notion of using experiential learning in order to create new knowledge while using contextualised experiences. Professor Laws (1991) inspired Sparks to consider the implementation of a "hands on", collaborative, computer-based "workshop" in his design of the new statics learning environment.

The Design of the New Statics Learning Environment

Funded by SUCCEED Professor Sparks designed an interactive multimedia computer-based learning environment to significantly improve learning and the accomplishments of students who experience statics from the College of Engineering. The initial design for the new statics learning environment centered on the interactive multimedia software. Later, the focus changed from a computer based learning environment to a hands-on workshop environment modeled after Priscilla Law's (1991) Workshop Physics. Law's laboratory was restructured to compliment the new "hands-on" physics curriculum which focused on experiments and discussion of predictions and results to reinforce physics concepts. Students were required to work collaboratively in groups of four and use computer technology to report their results (Laws, 1991). Professor Sparks revealed this by saying, " We are using Authorware Professional to construct the multimedia program. As a consequence of this effort, the interactive multimedia software has evolved into a workshop environment that includes hands-on experiments and group activities in the context of experiential learning."

Curriculum. The content modules for the new statics learning environment were similar to the traditional statics curriculum since it included forces, equilibrium, plane structures, friction, fluid statics, spatial structures (see Appendix J for the new statics learning environment syllabus). However, Professor Sparks' curriculum emphasized fundamental statics concepts such as forces, equilibrium and plane structures. Therefore, content coverage was reduced compared to the traditional statics course. When I discussed the statics curriculum with Professor Sparks, he stated that the objectives for his classes originated from the traditional college curriculum, " There are certain fundamental concepts and principles that govern the behavior of structures, and there are certain tools that you need." Furthermore, he elaborated that it was his responsibility to make sure that the students understood the all the fundamental concepts and principles of statics set out by the college for the study of statics.

Professor Sparks aimed to integrate concepts and skills so that students could make connections with real life examples. He proposed, " If we want to stimulate something or integrate something it has to be close enough to have some ties, some meaningful connections already. If there is nothing there then you can't adapt it, so ... this is one of my explicit criteria for designing learning environments." He intended to introduce his curriculum via authentic tasks from the interactive multimedia software . The syllabus for the new learning environment included homework, ten quizzes, a mid-term and final examination.

Pedagogy. Piaget's (1954) notion of knowledge being constructed by the learner, and not transmitted by the instructor was the main tenant influencing the changes in pedagogy for statics. In addition to Piaget's notion of constructivism, Professor Sparks also adopted Kolb's

Experiential Learning Model where learning is considered to be a process which builds knowledge through the transformation of experience (Kolb, 1984). Within this model Sparks embraced the importance the collaborative construction of new knowledge by the learner (Vygotsky, 1978).

The new learning environment intended to replace traditional, didactic teaching with instruction that would assist student learning. Therefore, the role of the teacher would change from a transmitter of information to one of assisting students to self-regulation. Professor Sparks stated, " What is important to me is understanding is not memorizing and becoming independent. In fact that is a sign that they have learned something when they no longer need me."

The main components of the new statics learning environment included an overall teaching/learning framework from Kolb's Experiential Learning Model (1984), and the incorporation of the new pedagogical tools of cooperative learning and interactive multimedia see Figure 3.1.

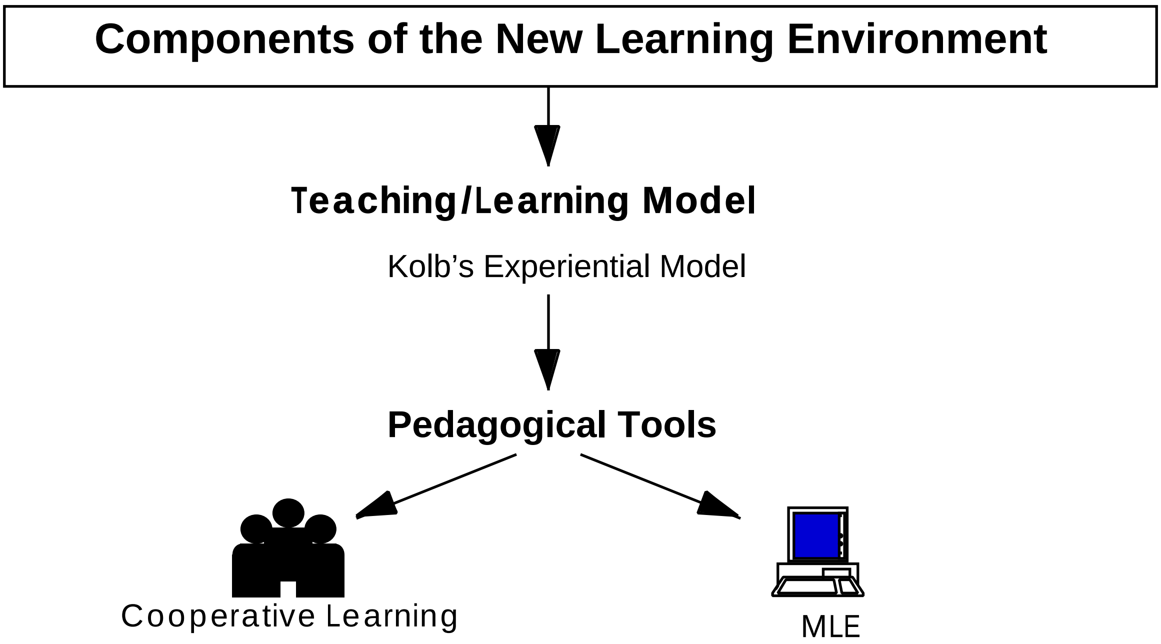

Figure 3.1 Components of the new statics learning environment.

Kolb's Experiential Learning Model (1984) model contains the elements of feeling (concrete experiences), thinking (abstract conceptualization), watching (reflective observation), and doing (active experimentation). Professor Sparks' interpretation of the model is displayed in Figure 3.2, where he illustrates the two basic dimensions of the learning process: grasping and transforming this experience into knowledge.

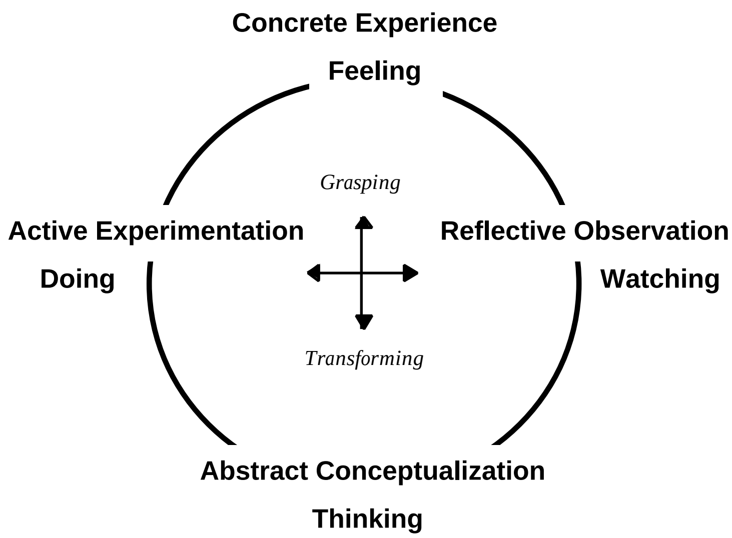

Figure 3.2 Sparks' experiential learning model (adapted from Kolb, 1984).

Professor Sparks proposed that each dimension of grasping and transforming contained two opposite but complementary modes of learning. Regarding grasping and transforming he stated,

> The two distinct modes of grasping are concrete experience and abstract conceptualization. This refers to tangible qualities of immediate experience and abstract conceptualization, grasping through feeling; the second refers to indirect comprehension of symbolic representation of experience, grasping through thinking.
>
> The two distinct modes of transforming experience are reflective observations and active experimentation. They emphasize carefully observing and describing how things are versus practical application, watching as opposed to doing. At any given moment, the learning process may involve one or a combination of these four adaptive learning modes. What is significant is that synthesis leads to higher levels of learning.

Professor Sparks aimed to promote learning connections with real life experiences. He designed the experiential activities to begin with a concrete experience to be demonstrated by the instructor or simulated on the computer. He said, " I am starting out with a concrete experience and then I encourage them to take this experience from the class and then reflect on it."

One of the key instructional tools used to promote student discussion and interaction was cooperative learning. Using the Johnson et al. (1994) definition, cooperative learning is the instructional tool that engages small groups in order to promote students working together and maximize their own and each other's learning. Professor Sparks clearly intended to use cooperative learning because he developed a handout that was distributed to the students on the first day of class. This handout outlined very explicitly how cooperative learning would be implemented in this class. First, there was Sparks' integration of cooperative learning activities into experiential problem solution. Activities were to be structured as follows, each individual should formulate his or her own solution. Next, the members of the group would need to listen carefully to the presentation.

And lastly, the group would create its solution by analyzing, questioning, testing, and synthesizing the individual solutions.

The five basic elements of the cooperative learning model were also articulated on the handout :

1. Positive interdependence. The performance of each member is vital to the group's success.
2. Promotive interaction. The members exchange ideas and help one another learn.
3. Individual accountability. Individual performance is evaluated and feedback is provided to the students.
4. Social Skills. The members acquire leadership, decision-making, trust-building, communication, and conflict-management skills.
5. Group processing. Groups assess their effectiveness and identify areas for improvement.

The other instructional tool to be utilized in the statics learning environment was the interactive multimedia software. This resource was designed to provide a vehicle for the delivery of instruction for the new statics learning environment. The work station consisted of an IBM 486 or IBM compatible computer. The software was developed over a period of two years by Professor Sparks and two graduate assistants. The interactive multimedia software's implementation in August 1995 was considered to be an "alpha" testing phase and part of the formative evaluation of the software.

The interactive multimedia software was designed to combine the advantages of multimedia and hypermedia to create an application that both stimulated and responded to the learner. This combination would allow extensive and flexible links among data in many forms such as text, graphics and animation. Sparks' intended design features of the interactive multimedia software included:

1. A hypertext environment that includes a Socratic approach of guided inquiry, e.g., the learner is encouraged via the Socratic approach to work out how the weight of a child is transmitted to the supports for various arm positions such as, single arm, parallel arms, and inclined arms.
2. Case studies, for example in plane structures problems are based on real examples such as a bridge over the Grand Canyon which provides students with a framework for mathematical modeling and calculations.
3. Feedback, such as constructive comments guiding students to the solution of a problem and providing correct responses.
4. Learning support tools through a tool box that incorporates a calculator to assist students with mathematical calculations.

<u>Procedures for the Class</u>. Professor Sparks designed the structure of the learning environment to include warm-up problems, experiential and cooperative activities and minute papers responses. He intended the commencement of each class with warm-up problems, approximately 5 minutes in duration. During this time Professor Sparks aimed to provide students with quick feedback by addressing problems or questions that surfaced in homework, weekly quizzes, and the minute papers. He also intended to present the lesson objectives during the warm up problem phase.

This was to be followed by activities consisting of mini lectures (10-15 minutes long) and experiential activities interspersed with collaborative group work. His principal goal was to promote active student learning. The experiential activities were designed to follow Kolb's learning modes of concrete experience, reflective observation, abstract conceptualization and active experimentation. Professor Sparks stated, " the names of the stages have been changed to reflect our learning activities. They remind us of the scientific method, which apparently was the model for experiential learning (Kolb, 1984)."

Below is an example of a typical activity and format that reflects the scientific method of problem solution :

1. Experiment (concrete experience) e.g., a four pound weight is supported symmetrically by strings and connected to spring balances.
2. Analysis (reflective observation) e.g., students construct a parallelogram whose sides correspond to some scale of the magnitude of the string forces. This activity may be completed on the interactive multimedia software but Professor Sparks envisaged sensory involvement as students completed the task with pencils, paper and protractors.
3. Hypothesis (abstract conceptualization) e.g., the students form a conceptual model of the physical problems and are asked to propose a geometric rule for combining two arbitrary forces to calculate the resultant.
4. Testing (active experimentation) e.g., students use active experimentation to test their hypothesis. More specifically, a weight is applied at an arbitrary point of the string support system, the string forces and the slopes of the strings are recorded, and the resultant is determined by the proposed geometric rule.

For each computer-based task it was Professor Sparks' intent for students to commence with a concrete experience (as indicated in the above example). Students were expected to individually formulate an answer, share their answer with their partner or group members, listen carefully to their partners solution and create a collective answer through discussion and experimentation with the computer. Cooperative learning was considered an important component of the learning process, particularly during the hypothesis phase by Professor Sparks because students were expected to propose a method for computing the forces. The final phase of the activity in this example, would involve testing the proposed method of analysis of joints to different trusses.

In order to provide Professor Sparks with feedback at the end of each session students would be asked to write minute papers. The minute papers consisted of questions about the day's lesson and activities such as, important points, surprises, questions, and changes that would facilitate the student's learning. It was Sparks intent to provide and respond to students with feedback regarding their concerns about the new statics learning environment.

Profile of Professor Sparks

Professional background. Professor Sparks commenced working at the Abbotsford University during 1972 as an assistant professor. He became a professor in 1980, and has been bestowed with many teaching awards from the college and also at the university, state, and national level.

Beliefs about teaching and learning. During our meetings and interviews, Professor Sparks often discussed his beliefs about learning. In one interview he described his philosophy underlying the changes for the new statics learning environment and stated,

> I keep coming back to Piaget's statement of the basic idea of constructivism that knowledge must be constructed by the learner. Actually, I have adapted his (Kolb's) definition and also Vygotsky ... mainly that learning involves two fundamental activities one is grasping experience and the other one is transforming this experience into knowledge. To me this ties in beautifully with what Piaget says, and experience is something that gets you emotionally involved, it captures you. To me this is so meaningful. The question is how can I facilitate that ?

Regarding his notion of connecting statics problems to real life experiences, Professor Sparks explained that,

> You have to have connections. You can't learn anything in a vacuum. So the key for me is to make sure I can help them realize the connections. I have to help them to tie what is new with something in their own experience ... if a student encounters something, that he or she cannot connect with the current knowledge structure, and its too far removed... then the student will not learn.

A focal point of the new statics learning environment was Professor Sparks belief of the importance of collaborative interaction. He said,

> I think that it is extremely important, it gives you (the student) feedback, it gives you other perspectives, it gives you support, it gives you a tutor, I think collaboration is so extremely important. In fact I think that if a person does not collaborate no matter how gifted you are, your work becomes sterile because you are not being challenged by someone with a different experience.

Summary

In summary, this chapter focused on Professor Sparks' expectations and intent for the design of his new statics learning environment. In essence, his intent was to transform the traditional statics curriculum by providing more depth for the learning of statics concepts at the expense of curricula breadth and to provide students with experiences so they could understand theoretical concepts. More importantly, for this initial iteration of this course, Sparks wanted to introduce collaborative group work and focus on experiential learning through the interactive multimedia software. Sparks, an award-winning professor, undertook these changes supported by his deep interest in constructivism, experiential, collaborative learning and technology.

Chapter 4

The New Statics Learning Environment Enacted

This chapter describes the implementation of Professor Sparks' new experiential teaching/learning model and his enactment of the pedagogical tools of cooperative learning and the interactive multimedia software. Also presented in this chapter are the findings from the new statics learning environment with a specific focus on the participants' perceptions of the pedagogical change.

This chapter is organized into the following sections. The presentation begins with an overview of the implementation of the new statics learning environment during the Fall semester, 1995, outlining the teaching events that occurred across the semester. Next, reported are the participants' perceptions of the three major pedagogical changes: (a) experiential learning, (b) cooperative learning, and (c) interactive multimedia software. In order to portray the many perceptions that existed in the new statics learning environment, the instructor, students, undergraduate teaching assistant (Mary), and the researchers' views are considered related to each of these innovations. Finally, other factors that affected the implementation of the new statics learning environment such as time and space are also discussed.

The Implementation of the New Statics Learning Environment Across the Semester

Professor Sparks began the semester with a description of his new statics workshop environment. He used the interactive multimedia software to explain the four modes of Kolb's (1984) experiential learning model and how discussed how his course aimed at providing "deeper learning" of the statics curriculum. He then distributed a handout explaining cooperative learning (which was previously discussed in Chapter 3). Each of the following classes were structured into three major phases. The first phase consisted of warm up problems (approximately 5 minutes). This is when Sparks would outline the lesson objectives and provide feedback to the students. In the second phase, Professor Sparks presented a mini-lecture (approximately 8-10 minutes, but this could vary to 40 minutes of discussion) and students participated in experiential and cooperative learning activities from handouts or the interactive multimedia software (this could vary from 15-30 minutes). In the third phase students completed their minute paper responses (approximately 2-3 minutes). See Appendix H for a complete detailed description of each class.

During the weeks that followed Sparks established general routine procedures for the operation of the class that were executed throughout the rest of the semester. The following is a summary of the routine procedures for each lesson during the fifteen weeks of observations by Dr. Lockee and myself:

Warm-Up Problems

1. Presenting an overhead at the beginning of each lesson which provided a plan of the day's activities.
2. Providing verbal feedback to the students regarding homework questions, quizzes and student minute paper responses.

Activities

3. Presenting a mini lecture of different topics for each class.

4. Presenting statics problems through overhead transparencies, handouts and tasks from the interactive multimedia software to engage students in collaborative problem solving.
5. Demonstrating experiments using concrete, real life examples such as a truss.
6. Engaging students in discussions about statics problems.
7. Monitoring and assisting students during group discussions and interactions as they solved problems collaboratively together.
8. Working through sample mathematical statics problems on the white board.
9. Providing written feedback (e.g. handouts) containing the solutions to homework and quiz problems.

<u>Minute Papers</u>

10. Encouraging student feedback through the minute papers.

In the warm up phase of the lesson, across the semester Dr. Lockee and I saw Professor Sparks stand at the front of the room and present a mini-lecture for each class. He would project activities from the interactive multimedia software via the LCD (liquid crystal display) connected to the overhead projector. He also used overhead transparencies and the whiteboard to explain solutions to statics problems. When delivering his lecture he used a long stick pointer to draw student attention to specific points. In an interview mid-way through the semester I asked Professor Sparks to describe his perception of the implementation of the new statics learning environment. He stated,

> Right now (29th Sept.), we have gone through a phase where we have used the computer very sparingly, and so in a sense what I did use was overheads and I used handouts with gaps like my other courses when I don't use the computer... So students are being introduced and then work in groups to become engaged through these handouts that contain gaps but very few students work as teams.

During each class Professor Sparks would discuss a topic (e.g. equilibrium), then set a problem, ask students to discuss the solution. After he would provide students with the correct response. For the most part Professor Sparks used questions to engage students in discussions however, due to the lack of time on 4 occasions, he would answer his own questions.

During an interview, upon my return to the site I asked Professor Sparks to describe the procedure for the new statics learning environment, he said, “ After I have discussed the topic for 8-10 minutes I ask every team, to have one person to summarize what I have been doing...and then the others listen carefully to that person and then start discussion on a topic, then raise questions, and pose the questions to me.”

Across the semester it became evident that Professor Sparks became directly influenced and frequently responded to the student minute paper comments (see examples in Appendix I). One particular example focused on the minute paper question, “ What changes would facilitate your learning ? ” A student responded, “ Putting me in the front again. ” In the following lesson on the 30th October, Sparks responded by moving that particular student to the front of the class. Another example was when Professor Sparks organized extra help sessions to address student concerns about homework problems and quizzes after one student commented in a minute paper response, “ Not enough time spent on homework” and another student made the request, “Extra study sessions will help a lot.” The supplementary sessions consequently liberated Sparks from his routine procedures of discussing quizzes and homework solutions to more time for collaborative group work with the interactive multimedia software in class.

The use of experiments was a major feature of the implementation of the new statics learning environment. Professor Sparks presented real life experiments (e.g., trusses or activities) to the students. The interactive multimedia software also contained experiments, students would make predictions and test their hypotheses. During our discussions Sparks said that he focused and responded to his students, and in fact this was his perception of student focused learning. This was evidenced by Sparks responsiveness to student feedback from the minute papers. For example, when a student suggested, “ The use of real experiments to show ideas,” Professor Sparks used real examples and experiments on four occasions following that comment on the 19th October.

In the minute paper responses, many students suggested more group work, for example, “We need to work in groups more often.” Another student said, “ It seems that we have gotten away from many group discussions.” In response, Sparks structured the following class on the 9th November around problems from handouts that he had prepared. Students were asked to collaboratively solve the problem during their group discussions.

Consistently throughout the semester students requested more work on the computer, for instance, “ More computers,” and “ What happened to the computer program ? ” During the following lesson, Professor Sparks responded by working with problems from the interactive multimedia software. Student comments that followed in the minute papers were, “ Good to get back to computer work. Doing a good job.” The fact that the interactive multimedia software was not complete impacted its use in the learning environment since only introductory modules on forces and plane structures were available.

In the beginning of the semester Sparks assumed a traditional role of providing students with the information they needed through lectures. It is interesting to note that when Dr. Lockee interviewed Sparks in September, 1995, he described his role in the new statics learning environment as minister and a conductor, he said, “ I want to tell them ! ” During my time in the statics learning environment (i.e., October, 17th until December 5th) I observed Professor Sparks moving from the traditional role of a dispenser of information towards an educator who assisted students to learn.

A change in Professor Sparks’ pedagogy occurred about the time students started to comment about the “roaming professor ” (3rd October). He began to decrease the mini lectures and teacher led discussions and increase and respond to student initiated discussions about static problems, and assist their learning in the new statics learning environment by helping and monitoring their progress during problem analysis and solution. Student comments in the minute papers also supported my observations. They said, “ I got a lot out of today’s lesson. It really helped when you walked around the class.” Another student commented, “ The roaming professor helps out a lot, too.”

This change was also reflected in interviews I conducted with Professor Sparks across the semester. Firstly, he compared his role to that of a carpenter, who provided the framework for learning. Later, he described himself as a director (i.e., a person who directed the learning). But during our discussions he told me that a director did not adequately describe his role anymore because the students had commenced to direct the learning in his classes. As the semester progressed he described himself as a facilitator who was responsible for creating an effective learning environment. During class Professor Sparks announced to the students, “ It is my job to facilitate your learning.”

Across the semester, students completed 9 quizzes, a major component of the students grade. During the semester the students suggested that the quiz be distributed at the end of the class instead of the beginning of class so that it would give them more time to complete the problems. Here, too, a change occurred over the course of the semester.

Initially, Sparks used the quiz as a means of assessment, but as the semester progressed the quizzes became more a tool for learning as he assisted them with the statics problems. One particular student said, “ I’m glad you came around to help. I learned more with this quiz and your help than I would have without your help. Thanks.” Professor Sparks provided verbal and written feedback to students when he distributed handouts containing solutions to the homework and quiz problems.

Professor Sparks made himself easily accessible to students during office hours and via electronic mail, students could also contact the graduate assistant, and the undergraduate teaching assistant, Mary, if they needed further assistance. Professor Sparks preferred to grade all quizzes and examinations, and the homework problems were graded by Mary. Students were evaluated on their performance on regular quizzes, homework, a mid-term and final examination. They were encouraged to work in groups and use the interactive multimedia software after class and to communicate via the statics listserv. Mary’s role in the new statics learning environment was to observe each class and provide support for students particularly with their homework problems, which she graded.

The mid-term and final semester student comments portrayed positive perceptions of the new statics learning environment (see Appendices K and L). Students were asked to rank the statics course on a scale of 1 to 5, with 1 being poor and 5 being excellent. During the middle of the semester two students ranked new statics learning environment as 3, one student ranked it a 3.5, two students ranked it a 4, and one student ranked it a 5. From an analysis of the electronic mail interview data, the criteria that students used to rank the new learning environment were (a) their respect for the instructor, (b) the use of stimulating materials, (c) the depth of explanation delivered by the instructor, and (d) the students depth of learning statics concepts.

At the end of the semester, the same 6 students were asked to rank the course. One student ranked the course a 3, one student ranked it a 3.5, another between 3 and 4, one student a 4.5, and two students ranked it a 5. The criteria that students used to rank the class were (a) their instructor was an approachable person and (b) the use of stimulating materials (see Appendix L for all the student comments). For example, John who ranked the class 4.5 said, “ I think it's really worthwhile, and I really think you are going to understand more about statics in this class than any other class.” Also, Tony who ranked the class a 5 said, “ I guess it would probably be a five. I mean I really enjoyed the material, and almost any way I can get it, it's going to be enjoyable.”

Student comments about Professor Sparks were extremely complimentary, for example students discussed his personable nature. Tony said, “ The way Professor Sparks was able to introduce it was that much better. Just because he was very open to students.” Many student were impressed with Sparks’ clear explanations of complex statics problems and the stimulating course materials he presented in class. For example, Fred who ranked the class 4.5 said,

> He's excellent. His whole attitude is really great. He gives you a chance to do it, and if you don't understand it he really goes back and spends a lot of time explaining it. He really goes back and spends a lot of time explaining it to you. It's really a great class if your unsure. I don't know whether that's because of the computer. I have a feeling its more because of Professor Sparks. Because he's just a great professor, he really instills confidence in you and working with smaller groups is easier than working with huge groups where you just feel out numbered. So, its a little more time to put into it in class, but I think in the long run its more exciting than a lecture and...you just learn more. I mean it's great, from what I've learned it's just

> I pick up everything well and really quickly and what I don't pick up comes from, if I look at it a couple of times it comes to me. So he's done a really good job presenting the information and giving us a chance to work on it. I think the only reason it wouldn't be a five is because it tends to be a little slow.

Similar attitudes were also reflected in the student minute paper responses, for example, " I remain impressed with the knowledge and determination to make this class happen, " " I understand- you explain things well , I really enjoy the way you look at things , and " It is so nice to see so much concern for our understanding of the material."

From the instructor's perspective, particularly when referring to the student grades Professor Sparks ranked the class highly as a "4". He based this ranking on the student scores from the mid-term examination, since sixteen out of 20 students were achieving an "A" standard of work. Professor Sparks used the quizzes, homework problems, mid term and a final examination in his assessment of the students.

Enactment of the Pedagogical Change

The analysis of the data on pedagogical change is organized into three sections to correspond with Professor Sparks intent for the new statics learning environment. They include the experiential teaching/learning model and the pedagogical tools of cooperative learning and the interactive multimedia software.

Experiential Learning

Professor Sparks adapted Kolb's (1984) experiential model as the primary pedagogy to frame the new statics learning environment. Figure 4.1 illustrates Sparks enactment of his experiential learning model. In each of the 15 classes across the semester Professor Sparks presented, at least one concrete experience (i.e., either from the interactive multimedia software or as an experiment). In regards to the abstract conceptualization phase of Sparks model, I observed students obviously thinking about and discussing the experiments with their group and predicting possible solutions to the problems. During the reflective observation component of the model, the students watched as Professor Sparks demonstrated the experiment and shared these experiences. The range of experiences included simple machines and trusses, computer animation and simulations from the interactive multimedia software. Students would watch and interact with the experiments from the interactive multimedia software and then work in their groups to discuss and formulate a mathematical solution.

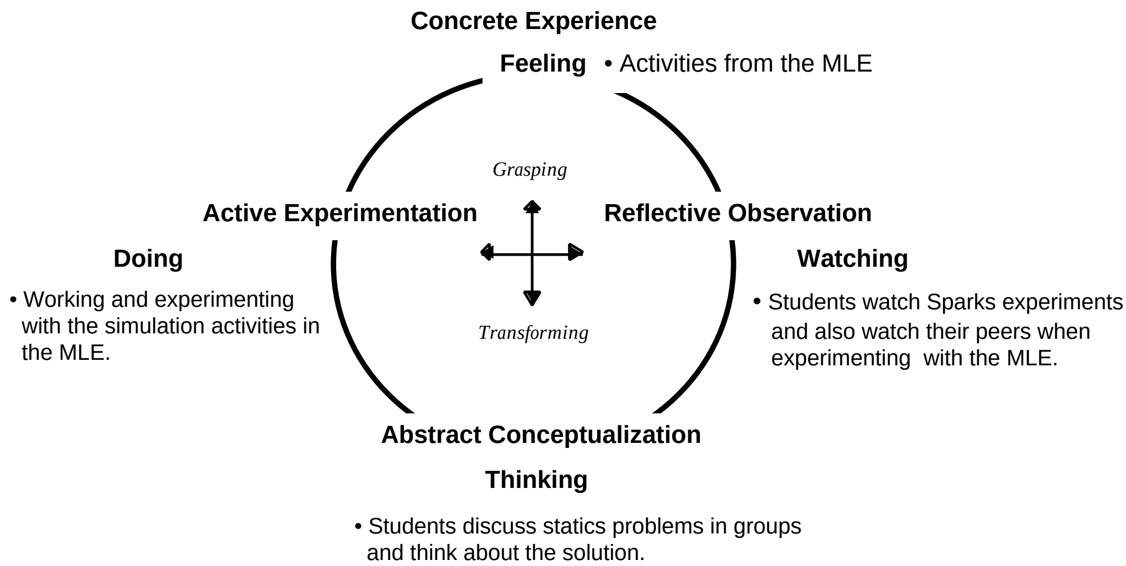

Figure 4.1. Sparks' enactment of Kolb's Experiential Learning Model (1984).

Student comments about the experiments were extremely positive particularly related to the experiments demonstrated by Professor Sparks in class (see Appendix O and Appendix P for mid term and final semester comments regarding experiential learning). For example, Lina said, " I enjoy real experiments where you can actually see, for instance, weights pulling on a cable as it actually happens. " John said, " I think that a physical example right in front of a person that they can interact with is the ultimate in teaching abstract concepts. For me, watching Sparks do those experiments I can figure out what's going on. I think ideally it should be what's suggested so far where there's a group and every group has that experiment where they can literally interact with it. " In addition to the interview data students also expressed positive comments in their minute paper responses, e.g., " The demonstration or visual aids really helped in demonstrating the ways forces are applied " and, " It is very helpful when I see a process that shows what happens when forces change, like the experiment, so I can interpret and understand."

Cooperative Learning

A major pedagogical tool used in the implementation of the new statics learning environment was cooperative learning. Based on our observations Professor Sparks implemented an informal model of cooperative learning which included to varying degrees the major components outlined by Johnson et al., (1994): positive interdependence, promotive interaction, individual accountability, social skills, and group processing. Positive interdependence was promoted in each class when Sparks would ask to discuss their statics problem with a partner or as a group of three. Groups were informally established during the first class and began to function in the second week of the semester. This occurred after Sparks gave a brief introduction and discussion about the concept and structure of cooperative learning, complimented with a handout outlining his cooperative learning model (discussed in Chapter 3). No formal roles were assigned to group members with no formal assessment activities set for each group as part of the positive interdependence component of Sparks' model.

The second component of Sparks cooperative learning model (i.e., promotive interaction) occurred when students exchanged ideas about solving statics problems and helping one another learn. This was evidenced by a comments in the minute papers, for example, " I realize how much more I learn when I help people learn " and, " As the semester continues I am realizing the importance of working in groups as part of the learning process. ” This was also supported by student comments during the interviews as Tony explained,

> The whole time it's back and forth. I mean Lina and Edwin were in my group and at one point Lina wouldn't understand something so Edwin and I would explain something to her. And then maybe Edwin wouldn't understand something so the whole time you're both learning and teaching at the same time.

Throughout the semester static problems were set by Professor Sparks, and then students would discuss and formulate solutions. It was extremely difficult for the researchers and Mary to see the promotive interaction between the students because the we all had assumed the role of non-participant observers and in the statics learning environment. We sat in the back, right hand corner of the electronic classroom. Consequently, the students were asked in interviews how their group functioned during cooperative learning activities. Vince provided an insight into how his group functioned. He described the nature of collaborative interaction with his group as one of assisting each other to learn.

> I mean one of us would always understand the concepts. The way it worked is, I would understand the concepts, one of them would understand or would listen to the professor and the other would take down how we were supposed to do the homework. And we'd all just kind of trade off and explain.

The third component of Sparks cooperative learning model, individual accountability occurred informally through verbal feedback to the students. Although tasks were completed during group interaction, there was no formal evaluation and feedback of individual student performance during these activities. During the third week of the semester Professor Sparks restructured the groups. This was because he felt students were not cooperating. He said, “ They are being exposed to cooperative learning, they’re not trying very hard... they are not trying unless I’m constantly after them... when I give them this chance they simply discuss things or sit around...”. During an interview with Jim he told me that he thought his group had been restructured because they were, “ Playing around with the computer.” He explained that his group had completed the set task, and had become bored while waiting for the other students to catch up.

Opportunities for group processing and accountability were enhanced when Professor Sparks intentionally restructured the minute papers on the 7th November. Students were asked to assess the effectiveness of their group and identify areas for further improvement. This provided him with more feedback about the cooperative learning component of the new statics learning environment. Consequently, questions were included to specifically focus on group activities: What are we doing well ?, and What improvements can we make ? (see Appendix G). From my observations across the semester Professor Sparks tried to keep the groups working at the same pace. His justification for changing groups was as follows,

> Once and a while I have to take time and say, gee, you have other objectives, not just to help them learn you know in other words I can justify actually experimenting even though it is not the most direct route for them. But I forget this sometimes. So finally when I changed the groups around before that I told myself hey, you are experimenting, even if your not too

> comfortable there ....my goal is for us to discover things not just for them to learn statics.

The groups were restructured again later in the semester. This occurred after one a student commented on a minute paper on the 24th October that moving to the front desk would facilitate his learning. In the following class Sparks responded to the comment and asked the student to move to the front of the class. Consequently, two dyad groups were formed at the front of the class.

The fourth component of Sparks' model was the development of social skills such as, leadership, trust building and decision making which were influenced by the restructuring of the groups across the semester. For example, Jim said, " I preferred working in the group that I was with at the beginning of the class. We all seemed to strengthen each other, not only because we knew each other well (John and Tony), but we knew each others' schedules and that seemed to be the basis for how strong our group was." Other students seem to adapt well to the change, Tony said, " The group that I am in is fine." He also elaborated in a later interviews that, " Being moved somewhere, out of my environment where I was really comfortable really made me question every little thing that came up." Fred also expressed a similar attitude he said, " I mean the people I've been working with are really great... Roy had a good background in Physics. Jim is great to work with he really knows what he is doing in class, it seems like he's almost bored with it sometimes, but he is really fun to work with."

Throughout the semester two different perceptions about the implementation of cooperative learning began to emerge as the students and Professor Sparks shared their thoughts with me during face-to-face interviews. On one side I heard extremely positive student feedback regarding the teacher-student and student-student interactions. On the other side Professor Sparks discussed his frustrations regarding the management of cooperative learning in the new statics learning environment. From an instructor's perspective Professor Sparks discussed his initial views on the implementation of cooperative learning. He went on to add, " It doesn't work according to the textbook recommendations**.** It doesn't I have tried it many, many times it doesn't because the thing is so fluid and spontaneous and so dependent on the characters involved....But in my class environment, ... it doesn't come naturally ... that's my problem. Students are being introduced and then work in groups to become engaged through these handouts that contain gaps, but very few students work as teams."

He did state that he felt as though he was at the beginning of an evolutionary process in regards to cooperative learning, and noting, " I have to learn more about it." Mary's observations also supported Professor Sparks' perception of the evolving nature of cooperative learning strategies in the new statics learning environment. She said, " I think it's evolving. I think in the beginning he kept switching groups... but now that they are in the same groups, I think it's working. "

In summary, despite Professor Sparks' initial frustrations with the implementation and management of cooperative learning strategies, it was evidenced from observations, the student minute papers, and the interviews, that students enjoyed the opportunity to interact, discuss, learn and teach each other, but most importantly interact with Professor Sparks. During the interviews with the students I asked them to discuss their feelings about cooperative learning (see Appendix M). It was interesting to note that the 6 students who participated in the electronic mail interviews praised the benefits of cooperative learning. Students cited following 3 advantages (a) verbalizing your thoughts to peers facilitates your learning, (b) it is sometimes easier to understand a concept when it is explained by your peers, and (c) explaining concepts to your peers facilitates not only your peer's learning but also your own learning.

Some of the student comments included, " The whole idea of cooperative learning is a great method of teaching. It works in that things can sometimes be explained better coming from your peers and a group situation " (Fred), " I think its working fine, it is definitely a help to understanding the concepts. Some of us also used it outside of class, and it's worked really well " (Vince) and " I am finding that I learn a lot more when I have to explain myself to others " (Tony).

The final semester student comments regarding cooperative learning were also favorable, students expressed the importance of the collaborative interaction with their professor and fellow students (see Appendix N). One of the students, Fred acknowledged the opportunity to collaboratively interact in the new statics learning environment during an interview he stated, " That's something else I like about this (statics) is that it wasn't me and 90 of my best friends. This was me and maybe 15 or 20 other people and a professor." This was also strongly supported by other student comments in the minute paper data regarding cooperative learning (see Appendix H).

Interactive Multimedia Software

The interactive multimedia technology was another pedagogical tool incorporated into the new statics learning environment by Professor Sparks. This tool presented experiential learning activities to the students. When reading this section the reader should keep in mind that the interactive multimedia software was only in alpha testing phase (i.e., first run, output version). Being in this developmental phase, the software was continually revised throughout the course of the semester by Professor Sparks and his graduate assistants.

Sparks chose to lead the navigation of the interactive multimedia software in the new statics learning environment. He demonstrated and guided students as they followed his navigation through the software. This caused some frustrations for the students. They commented, " A group member was slow to navigate, causing the whole group to fall behind," and " I don't think the students need to work on computers during class- it only slows us down and we follow what you do anyway. I think you using the program is sufficient...in short I think using the computer during class draws away from the material we are trying to learn and bogs us down in keeping up with the computer."

Across the semester, from our observations, " lack of time " appeared to be a key reason for the limited opportunities for students to navigate and explore the software on their own during class. On three occasions students stayed during their allocated break time to work with the interactive multimedia software. The use of the software after class hours was not recorded systematically. Professor Sparks did note that few students accessed the interactive multimedia software after class hours. Only two of the interviewed students reported that they returned to the computer lab in the evening to use the software.

Two perceptions evolved, as Professor Sparks and the students shared with me their feelings about the interactive technology throughout the semester. On one side Professor Sparks expressed his enthusiasm about the evolving nature of the interactive multimedia software. His focus was on the development and implementation of the software. The students focus however, was on the use of the interactive multimedia software in the new statics learning environment. They wanted to use the interactive multimedia software more in class. As mentioned earlier, what was interesting was that both the some students and Sparks reported that many did not use the interactive multimedia software when it was available to them outside of class hours.

During an interview early in the semester Professor Sparks indicated his enthusiasm about the implementation of the software. He felt that the experimental nature of the restructured statics course provided him with the opportunity to use the interactive multimedia software in a real life educational context. This experience proved to be an important component of the formative evaluation of the interactive multimedia software. He elaborated on this point during an interview,

> The most exciting thing to me is that I am getting ideas about the course and I am finding connections that I had not previously linked that closely, so this teaching is really helping me simplify the course and realize new ways of presenting material and helping students make connections, so that is very valuable. New learning modules... we have restructured the interface already. It is easier to use. I will show you at some later date some of the simplifications of navigation simply came about because I had to work with it and I needed short cuts, so in effect it is very exciting, even though I have some frustrations with the students.

On the 5th December Professor Sparks distributed a questionnaire he had developed regarding the interactive multimedia software to all the students in the class. All students strongly attested that the interactive multimedia software assisted their learning (see Appendix Q). The interactive multimedia software provided a concrete model for Professor Sparks to lecture around and visual examples to reinforce statics concepts. Some of the student comments included, " This class has definitely made a big difference. I think that once a few small things are modified and the program is complete this will be a real motivation for this type of education," and " I only wish I could take next semester in here as well. I'd rather not go to the lecture hall for Strengths, " and " The (interactive multimedia software) provided visual examples that helped reinforce concepts that were taught. The new animation's of FBD's (free body diagrams) you construct are especially useful." Unfortunately, no feedback from Professor Sparks was available at this point in the semester to compare with the student data.

Initial student impressions of the interactive multimedia software indicated that they were very impressed: " I like it, " and " The program seems rather self explanatory." As the semester progressed, however many students began to express their confusion about the actual use the interactive multimedia software in the new statics learning environment. For example, from the minute paper responses students said, " We are not using the computer," " I am not sure the computer program will help our understanding of ideas," and " I am a little confused by the use of computers." They stated their expectations during interviews they cited the interactive multimedia software as the main reason they volunteered to participate in the experimental statics course. Mary (undergraduate assistant) also commented during the final semester interview about the use of the interactive multimedia software in the statics learning environment. She said,

> I see him (Professor Sparks) leading all the computers. Never does he say OK you've got 15 minutes go through that program. Occasionally he says answer this question now. But it's one question. It would be nice if it would be like equilibrium and they could play around in there for 1/2 an hour and see what was going on, because it's a very user friendly program. I think the computer program still needs some work. It's been getting better as we go along.

It appeared that their comments were not directed towards the software, but rather its implementation in the new statics learning environment. In contrast, Professor Sparks appeared to be primarily concerned with the software itself. Professor Sparks explained to me and the class that the interactive multimedia software was not complete and did not contain all the content modules for the statics course.

During the interviews students discussed their perceptions of the interactive multimedia learning environment (see Appendix R). Their confusion is illustrated by the multiple realities that one could expect across individuals. Some of the comments cited components of the learning environment to be (a) computer, (b) calculators, (c) quizzes, (d) demonstrations, and (e) hands-on experiments. In contrast, Professor Sparks described it as a computer-based environment in which information can be accessed interactively and in multiple forms such as text, graphics, and simulations.

All in all, student feedback about the design features of the interactive multimedia software were generally positive (see Appendix S). In particular, the screen design, the use of illustrations and computer simulations of free body diagrams assisted students to visualize fundamental statics concepts. The navigation feature of the software appeared to cause some students concern. Students felt that it was somewhat difficult to follow Professor Sparks when he would guide them through the software. One student mentioned that Professor Sparks' computer was faster than the student computers and this was the cause of the problem.

Factors Influencing the Implementation of the New Statics Learning Environment

The constraints of time and space presented Professor Sparks with additional challenges during the implementation of the new statics learning environment. Of primary concern was time, particularly the lack of time to cover all the content required by the College of Engineering. Sparks said,

> I'm always rushed for time, I am always short of time. In fact the learning environment and the objectives are such that we simply do not have enough time so I keep constantly looking at my watch and thirty minutes have gone by, because we do so many things, I respond to their problems on the homework, I respond to their flaws that I detect on the quizzes and then at the same time I project ahead to the new homework assignments. I prepare them for that, I have new topics to cover...

Across the semester, time was also considered an issue by the students. During 4 separate classes, the student minute papers responses requested that Professor Sparks slow down, e.g., " Professor going too fast," " Let's discuss straight way, professor going too fast, " " Please professor slow down material was presented too quickly, " and " Could you really slow down when explaining ? "

From my observations student interaction was affected by Professor Sparks' lack of class time. Sparks allowed approximately between 3 and sometimes 5 minutes of class time for student discussion of each statics problems. In their minute paper responses students often requested more time to work with their group, " Give us longer to work on problems, " and " Allowing more time to work together to answer questions," and " Having plenty of time to work on the problems together, " and " Discussing and brainstorming more."

The physical environment played an important and often underestimated role in the implementation of new curriculum and pedagogy. From the researchers' observations the physical layout of the electronic classroom prevented cooperative and experiential learning activities because there was little space for student interaction, particularly for all the groups consisting of three students (see Figure 4.2). For example, in a minute paper response one student suggested, “ It would be better in a circular group arrangement as opposed to linear.” In an interview another student said, “ It's kind of hard to work in group when you're in a line. You know that doesn't work real great either.”

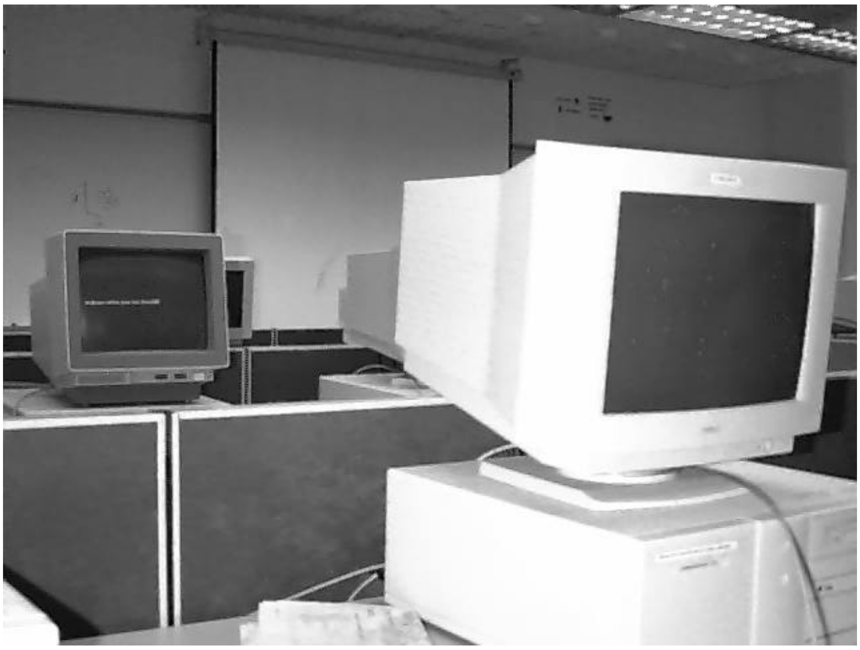

Figure 4.2 The electronic classroom from a student’s perspective.

Student comments from the minute papers and interviews revealed “space” as a constraint that prevented collaborative interaction with other students. There was no desk space, particularly when students were trying to write notes during the lecture component of the class. For example, a student said, “ It’s difficult and uncomfortable to do all the work on your lap. The area is crowded and not everyone in the group can use the computer. I find it very difficult to work in my group with this setting set up.” Another student suggested, “ The layout of the room should be better to allow each student to see the professor without difficulty, each member to have access/see what is on the screen and still have a place to take notes. ”

From our observations students were unable to see the Professor as he presented his experiments at the front of the classroom. The positioning and height of the computers prevented a clear sight line to the front of the class (see Figure 4.2). From a student’s perspective the physical environment was a major obstacle to learning in the new statics learning environment. For example,

> I know when you're sitting there and you have all those computers screens in between you and the professor that makes it hard to hear him and hard to pay attention. You can get easily distracted that way... The lab room is awful for learning.

Student feedback about the layout of the classroom occurred repeatedly throughout the semester. When asked during the interviews about changes to the new statics course (see Appendix T) many students commented about the layout of the electronic classroom. Some of the comments included, “ I would change the layout of the learning space, ” and

" Maybe the layout of the lab for more desk space. "

Summary

In summary, across the semester the general class procedure of warm-up problems, mini-lectures, group activities with the interactive multimedia software and student feedback from the minute papers remained constant. From an analysis of the data, the main features of experiential learning implemented by Sparks in the new statics learning environment involved primarily him sharing real life experiments as the students watched. Opportunities for student experimentation occurred when students interacted with problems from the interactive multimedia software. The changes observed over the semester involved Professor Sparks reducing the lectures and teacher led discussions and increasing problem solving activities where he functioned as the "roaming professor."

The main features of cooperative learning implemented by Sparks involved the promotive interaction of students. Data collected during this study revealed that student discussions of the statics problems helped one another learn. Opportunities for student reflection about group processes were evidenced in their minute paper responses. Divergent perceptions regarding the implementation of cooperative learning were also evident. First, Professor Sparks frustration concerning management issues, and second, students' positive reaction to cooperative learning in the new statics learning environment.

Regarding the implementation of the interactive multimedia software, much of the time was spent with Professor Sparks guiding the students as they navigated through the software. This in addition to, the fact the software was not complete, caused the students to question the role of the technology in the new learning environment. Overall, however, the students found the software helpful.

Related to the dilemmas of the pedagogical changes, two additional challenges confronted Professor Sparks as he implemented his new statics learning environment. One of the challenges was the constraints of time, since Professor Sparks attempted to cover the mandatory statics content in more depth. This caused Sparks a great deal of concern and also frustration, and influenced the extent to which the students navigated the interactive multimedia software on their own. Another constraint cited was the physical environment for the experimental class. Due to the cramped conditions and the architecture of the computer hardware and furniture, the electronic classroom did not support the collaborative and experiential nature of the new learning environment designed by Professor Sparks.

Chapter 5

Conclusions

This final chapter presents the major issues that emerged from this study, offers connections to theory, and poses final comments and conclusions. The chapter begins with a discussion of the major issues relating to the teacher change process documented in this study. These issues focus on the challenges and frustrations experienced by Professor Sparks during the day-to-day enactment of the new statics learning environment. Subsequently, a discussion is provided of what happens when an educator, such as Professor Sparks undertakes a paradigm shift. This chapter concludes with recommendations for future research and final comments about the teacher change process.

As previously mentioned Fullan (1982) identified four broad phases of educational change to include, initiation, implementation, continuation and outcome (see Figure 5.1). This study addressed the first two phases of the teacher change process beginning with Professor Sparks initiating a change in his pedagogy. The direction of change moved from Sparks' intent to his enactment of the new statics learning environment during the implementation phase. Therefore, documented in this dissertation are the initial experiences of the study respondents during Fullan's (1982) phase I (initiation) and phase II (implementation) of the teacher change process.

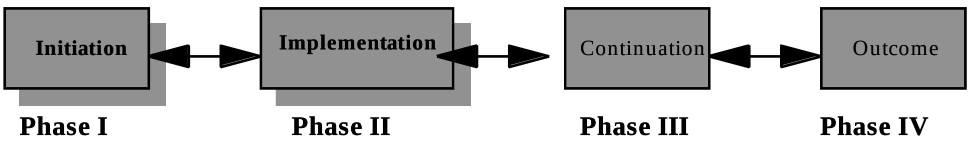

Figure 5.1 The overview of the change process for this dissertation.

Based on a close examination and triangulation of classroom observations, interviews, documents and questionnaires the following major issues relating to Sparks pedagogical change emerged:

1. The problem of the simultaneous introduction of three new innovations.
2. The frustrations of the teacher change process for the study respondents.
3. Difficulties of a paradigm shift in pedagogy and relinquishing control in the new statics learning environment.

<u>The Problem of the Simultaneous Introduction of Three New Innovations.</u>

An innovation is defined by Rogers (1983) as, " an idea, practice, or object that is perceived as new by an individual or other unit of adoption " (p.11). He maintains that getting an idea or innovation adopted, even though there are many advantages is still a very difficult process. In this study Professor Sparks did not introduce one, idea but *three* innovations simultaneously into the new statics learning environment. In essence, he tried to make changes that are very difficult to implement within a limited amount of time (Brown, 1994). The innovations included a new teaching and learning methodology based on Kolb's experiential model, and the pedagogical tools of cooperative learning plus the interactive multimedia software.

Fullan (1994) reminds us that during the teacher change process a teacher should welcome problems. An educator cannot change without experiencing then, they are an inevitable part of the teacher change process. Even though Professor Sparks espoused a strong desire to change his pedagogy and obtained funding to develop the interactive multimedia software, he experienced many challenges during the initial stages of the teacher change process. Several driving and restraining forces influenced the change process. The challenges faced by Sparks during the implementation of new statics learning environment are summarized below (see Figure 5.2).

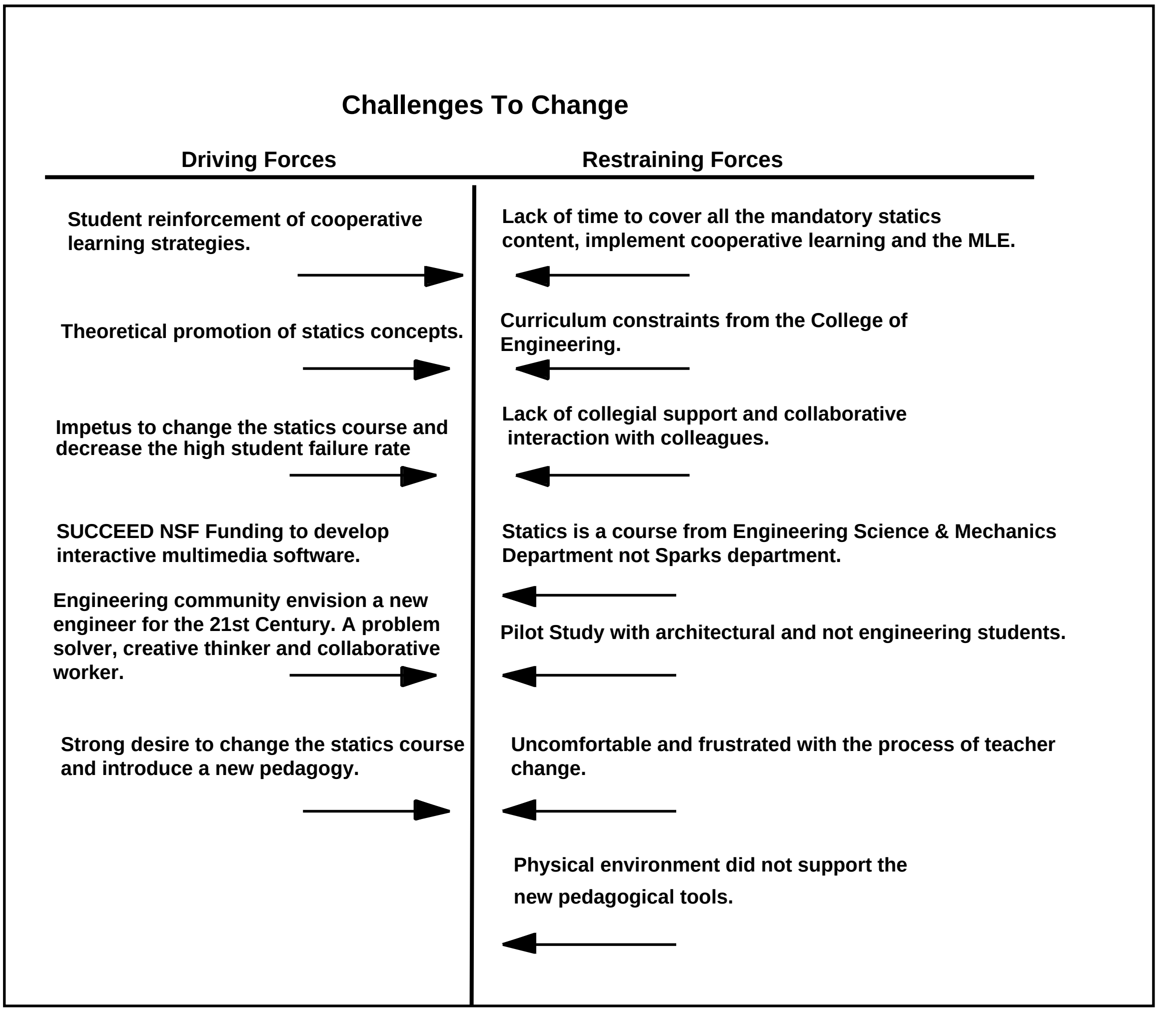

Figure 5.2 Driving and restraining forces influencing the new statics learning environment.

To elaborate on Figure 5.2, one of the driving forces in the new statics learning environment were positive student reaction to Professor Sparks use of cooperative learning in the new statics learning environment. Also, evident was their appreciation of the experiments Sparks used to connect their experiences to the complex theoretical statics concepts. This was counteracted by the restraining force of the lack of time to cover all the mandatory statics content which also affected Sparks' management of cooperative learning and the use of the interactive multimedia software in the new learning environment. Consequently, little time was afforded to students for working in groups and using the interactive multimedia software in class.

The driving forces to change the statics learning environment was due to the National Science Foundation and Teaching and Learning Center funding, Sparks' review of educational literature and his design of a new pedagogy, and also his strong desire to reduce the failure rate for statics. This was counteracted by the restraining forces of the extensive coverage of statics content required by the College Of Engineering. Sparks felt extremely pressured because of his intent to reduce the quantity of the content and provide students with a “ depth of knowledge” about statics. His new curriculum focused on static concepts and their connections to real life examples. The curriculum constraints from the College of Engineering also presented related challenges for Sparks as he implemented his new pedagogy. He was constantly concerned about the lack of time to cover the content he needed to address.

Two factors known to facilitate the teacher change process are collegial support and peer collaboration (Little, 1981, 1986, 1987; Erickson, 1994; Fullan, 1982, 1994; Martin, 1993). During the development of the interactive multimedia software and the implementation of the new statics learning environment, Professor Sparks worked primarily in isolation, apart from the assistance of his two graduate students. This was another restraining force facing Professor Sparks. Little (1981,1986, 1987) affirms that change is extremely difficult without collegial support. Fullan (1982) states that, “ Teacher’s relative classroom isolation, lack of time to reflect and discuss the meaning of change, and lack of a culture which promotes or sanctions teacher-teacher exchange. For those as well as other reasons... teachers should not be left alone ” (p.120). Furthermore, Fullan (1994) argues that, “ individualism and collectivism must have equal power ” during the teacher change process. Fundamentally, he refers to educators valuing group process during the development and implementation of innovations and not working in isolation during teacher change.

From the data collected and my observations of the interactive multimedia software project, Professor Sparks did not engage in a great deal of interaction with his engineering colleagues regarding this course, therefore, affording him little opportunity for collegial interaction. This may have been because he developed a new course for a different department. It is the Engineering Science and Mechanic Department who oversees the statics course, while Sparks was based in the Civil Engineering Department. Fullan (1982) states, “ Innovations decided on or developed by teachers require teacher-teacher interaction, if they are to go anywhere... the more teachers can review and interact concerning their practices, the more they will be able to bring about improvements that they themselves identify as necessary. Teacher interaction is essential for successful change ” (p. 122). In addition to the other restraining forces, Professor Sparks piloted his new statics learning environment with architectural students and not engineering students for which the interactive multimedia software was specifically designed. Also, the physical environment did not support the introduction of the new pedagogical tools.

Another restraining force was the frustration experienced by Sparks and the students. Across the semester time became a constraint that caused Professor Sparks not only a great deal of concern but also frustration as he tried to manage cooperative learning strategies in the new statics learning environment. While Felder (1995) acknowledged the benefits of cooperative learning from his study, he also cautioned engineering educators about initial student resistance to the new pedagogy and change. In this study students became frustrated because of the lack of time and space for their collaborative group work (previously discussed in Chapter 4).

<u>The Frustrations of the Teacher Change Process</u>

Change whether planned or unplanned brings stress and anxiety. The frustrations of teacher change are well documented in the literature (Fullan, 1982, 1994; Marris, 1975). Moreover, change is considered a struggle that many educators fail to recognize as natural and inevitable (Marris, 1975). It is argued by Burke (1982), that what people resist is sometimes not change but loss, or the possibility of loss. Schön (1971) further states that change involves, “ Passing through the zones of uncertainty ... the situation of being at sea, of being lost, of confronting more information than you can handle ” (p. 12).

Nevertheless, change is considered the secret to further growth and the professional development for educators (Fullan, 1994).

Teacher change is a journey of uncertainty (Fullan, 1994). In this study Professor Sparks experienced frustration as he under went a paradigm shift to change his pedagogy. During an interview he said, “ I told myself, hey, you’re experimenting, even if you’re not too comfortable there.” Despite Sparks’ frustrations with the management of cooperative learning in the learning environment, responses from the minute papers and students interviews were positive. The students enjoyed and were extremely appreciative of the opportunity to collaboratively interact with their professor and fellow students. Felder (1995) also noted overwhelmingly positive student responses to cooperative learning in his study. The open ended responses about cooperatively learning were similar to the student responses in this study such as, “ It helps me understand better when I explain things to others ” (p. 366).

Fullan (1994) asserts that the educator cannot mandate what matters during the teacher change process. This was the case in this study since the electronic classroom was not an issue with Sparks however, the students perceived it to be extremely unsuitable for learning. It was evident that during Professor Sparks enactment of his new pedagogy throughout the semester that the physical environment did not support the changes he was trying to implement. The electronic environment contained little desk space for collaborative and experiential activities which in turn caused the students are great deal of frustration. They continually voiced their discontent about the electronic classroom in their minute paper responses throughout the semester. As previously mentioned students became frustrated because of the lack of time and space for their collaborative group work.

<u>A Paradigm Shift - Relinquishing Control</u>

A paradigm shift is commonly referred to as changing the way one views the world (Martin, 1993). This dissertation illustrates a paradigm shift initiated by Professor Sparks from a traditional engineering pedagogy to the implementation of a new teaching/learning model and pedagogical tools. Central to any shift in how we view teaching and learning is the issue of authority and control (Martin, 1993). In this study the issue of control is examined through the changing role of the Professor Sparks in the new statics learning environment (see Figure 5.3).

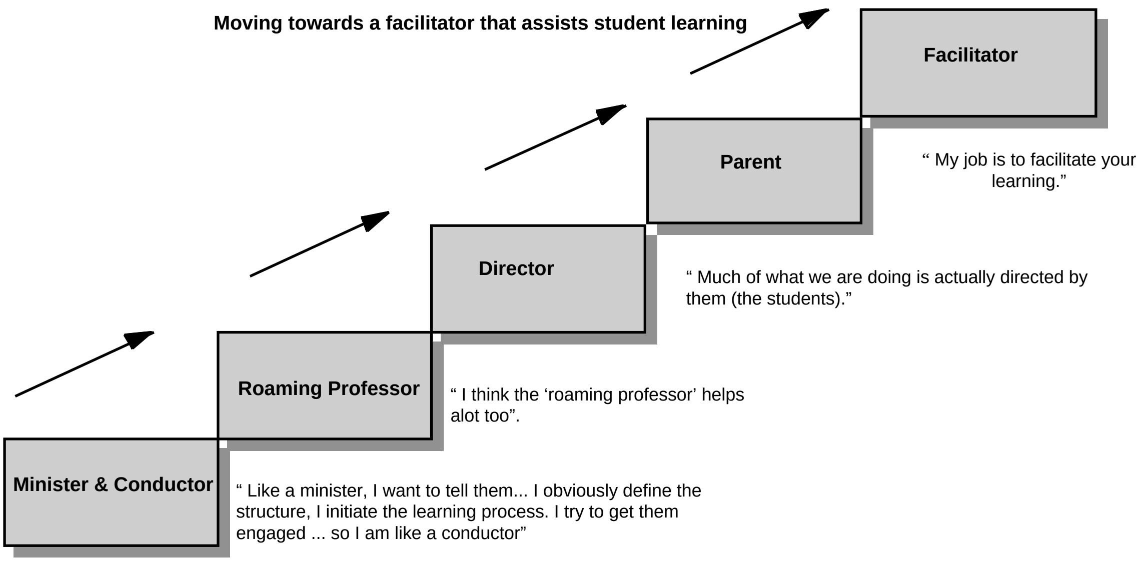

Figure 5.3 Changes in the role of professor sparks in the new statics learning environment.

Hannafin and Savenye (1993), argue that a teacher’s role does not simply change by using a computer in the learning environment. In relation to this study, at the beginning of the semester Professor Sparks enacted the role of an traditional educator, that is, providing students with information during the beginning of the semester. In explaining his role Sparks said, “...like a minister, I want to tell them do that... I obviously define the structure...I initiate the learning process. I try and get them engaged...so I am like a conductor. I define the environment, I know what is important, I define the goals, I monitor what they are doing, helping them..."

Hannafin and Savenye (1993) assert, “ The change occurs only to the extent to which a shift of responsibility to the learner occurs. The more responsibility and freedom given to the learner, the greater the shift in the teacher’s role ” (p. 28). Felder (1995), also affirms, “ Faculty members need to move away from the safe, teacher-centered methods that keep them in full control of their classes to methods that deliberately turn some control over to students ” (p. 367). Professor Sparks had started to relinquish some of the control in the new statics learning environment over the course of the semester. It became evident that the responsibility for learning was shifting towards the students as Sparks undertook the role of the “roaming professor.” Hannafin and Savenye (1993) also maintain that one begins to see a change in the student/teacher relationship and consequently the teacher’s role when the learning environment becomes more student directed. There was also an indication that Sparks had begun to delegate authority when he discussed with me how students had begun to direct his class. He stated, “ Much of what we are doing is actually directed by them, I think (the analogy of) a director in a sense is not a good choice anymore because if students can change my planned presentation by 50% that is a strong influence for what we are doing, the goal hasn't changed, but the directions have changed.” Because of Sparks’ nurturing attitude towards the students he also viewed himself in the role of a parent.

Literature from the field of instructional technology supports the role of a facilitator in a computer based learning environment (Fawson & Smellie, 1990). Professor Sparks’ role during his implementation of the new statics learning environment can be best described as a shift from a traditional deliverer of information to one that commenced facilitating and assisting student learning.

Fawson and Smellie (1990) report that educators who have successfully integrated computers into the learning environment break away from the traditional role as a dispenser of information to one of a facilitator. By the end of the semester Professor Sparks indicated that he had started to view himself as a facilitator, he clarified this by saying,

> To facilitate learning means to me : to create an effective learning environment, this includes sensitivity to student's interests and needs, caring for them, their learning, and development; providing concise course materials, rich learning resources, and meaningful activities and connections; a friendly setting that promotes social interactions; and guided discoveries that enhance learning skills and promote life long learning.

At the end of the semester, an interesting and insightful observation was made by Jim, a student who commented on Professor Sparks’ changing role in the new statics learning environment. He stated, “ The more the computer software is developed, Professor Sparks’ teaching techniques are going to change... his ways of teaching are going to change, then that will in turn change the software. So that type of relationship, once that becomes stronger then I think that it will tend to gravitate more towards the teacher as a facilitator.” Therefore, Sparks as well as the students, started to view the instructor’s role as a facilitator.

Conclusions

Kurt Lewin (1958), a psychologist and educator presented the analogy of a melting ice cube to describe the three phases of change : unfreezing, moving - changing and refreezing (see Figure 5.4). This analogy is appropriate to use within the context of this study to describe the paradigm shift an educator experiences.

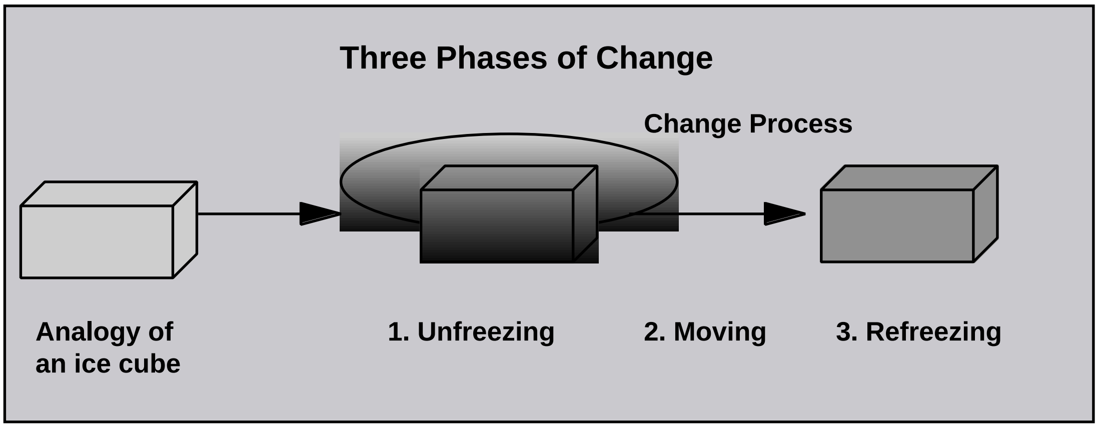

Figure 5.4 Three phases of change.

In his theory of change Lewin (1958) argued that in any social situation there exists a field of forces that maintains people's behavior. He refers to this state as a "quasi-stationary equilibrium." In order to alter the behavior of people, the equilibrium must be shifted to a new level, therefore unfreezing the ice cube. This involves altering the limits of the equilibrium by creating an awareness of a need for change and a desire for change. The process of change also involves "moving" where, one actively manipulates the social forces to decrease the restraining forces and increase the driving forces to a more desirable level of behavior.

Finally, in the refreezing phase, the equilibrium is stabilized at this level of behavior, insuring that the social forces will remain stable and will not revert to the prior state. Lewin's notion of change is compatible with Piaget's (1954) notion of equilibrium and disequilibrium during learning. In this instance an individual must feel some sense of discomfort for learning to take place.

In regards to this study the ice cube commenced to melt when Professor Sparks expressed the need for change and initiated it by redesigning the statics learning environment to reflect a new pedagogy. In this instance the restraining forces were stronger than the driving forces, therefore making it extremely difficult for Professor Sparks to implement his new pedagogy. During the process of moving or changing Professor Sparks experienced Piaget‘s (1954) previously mentioned notion of "disequilbrium”. Moving or changing in the future will require Professor Sparks to decrease the restraining forces and increase the driving forces (Lewin, 1958). For refreezing to occur Sparks will need to overcome the restraining forces and maintain his new pedagogy. Teachers are learners and their learning occurs in their workplace, the classroom (Martin, 1993). Clearly, the classroom served as the primary focus in which change promoted Professor Sparks pedagogical thinking and actions during the implementation of the new statics learning environment.

Recommendations for Future Research

Three major directions for future research in change contexts resulted from my reflections on this study. First, I would recommend a more systematic method of observation to be undertaken by the researcher. I feel it is necessary for videotaping or audio-taping to ensure an accurate representation of the teaching events that actually occurred over the course of the semester. Due to the initial implementation phase of these innovations, video or audio recording were not possible. This source of data would have allowed for a more systematic analysis of data particularly, since I was absent from the site for the first 6 weeks of observations. Second, I would recommend that future research should focus on in-depth case studies of students in the a new learning environment. For example, a comparison of a student who coped and adapted extremely well to the new statics learning environment contrasted to another student who didn't cope as well. Again, because of my absence and with only six student volunteers, I was unable to collect any in-depth data with the students. Their individual perceptions were recorded only in the interviews I conducted, since the minute papers were anonymous. Had I been in the site the entire semester I could have collected more in-depth observational data commencing at the beginning of the study which could have continued through the semester. Third, I would like to emphasize the need for a collaborative relationship between the researcher and the teacher. For both involved in the research process, this study highlighted the importance of open communication and the willingness to discuss, listen and reflect upon teacher change.

Final Comments

Change is an on-going process somewhat like learning: it could be said that teacher change is also teacher learning (Martin, 1993). The new statics learning environment has evolved and will continue to progress through the change process, as will Professor Sparks' transformation of his own pedagogy. However, this process takes time, Fullan (1994) recommends a period of three to five years for the four phases of the teacher change process to occur. It is argued by Brown (1994) that new learning theories and pedagogies espoused in the literature are just too difficult for educators to implement. This is one of the reasons that teacher change is so slow. She says, " It is easier to organize drill and practice in decontextualized skills to mastery, or manage 164 behavioral objectives, than it is to create and sustain environments that foster thought, thought about powerful ideas. We are asking a great deal from everyone in the learning community " (p.11).

Felder (1995) agrees and advises engineering professors to, " ... accept that while they are learning to implement active and cooperative methods they will make mistakes and may for a time be less effective than they were using old methods. They may also have to confront and overcome substantial student opposition and resistance, which can be a most unpleasant experience, especially for teachers who are good lecturers and may have been popular with students for many years " (p.367). His message advocates the benefits of a new pedagogy, such as the one espoused by Professor Sparks, e.g., " ... the benefits of the new approach more than compensate for the difficulties that must be overcome to implement it " (p. 367). This dissertation has provided me with an insight into the teacher change process, it has illustrated that change is a difficult, frustrating and very time-consuming process. To conclude,

> Instructors who pay attention to sound pedagogical principles when designing their courses, who are prepared for initially negative student reactions, and who have the patience and the confidence to wait out these reactions, will reap their rewards in more and deeper student learning and more positive student attitudes towards their subjects and about themselves.

It may take an effort to get there, but it is an effort well worth making (Felder, 1995, p.367).

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APPENDIX A

Informational Consent Questionnaire

A restructured statics course has been developed by Dr. Sparks to improve student achievement through a learning environment that incorporates interactive multimedia, experiential and collaborative learning. I invite you to participate in a study that investigates this new learning environment.

This research project involves my observations of your learning and interactions with other students and resources in the statics course during Fall, 1995 semester to be conducted at Abbotsford University. It may require your participation in two interviews, listserv comments and minute papers throughout the semester. Each interview will be audio taped and will be transcribed either by the researcher or secretarial support from the Department of Civil Engineering. This study does not affect any grade for the statics course you are taking.

Occasionally classroom interactions will be interviewed by the researcher and university faculty who are members of the researcher’s doctoral committee. The researcher will transcribe the tapes. You are invited to view these tapes and discuss your interpretations of your role and learning during these interactions.

The brief questionnaire aims to identify students willing to participate in the research project. Please indicate your willingness to participate in this study by checking (√) the following boxes:

Observations ❑ Interviews ❑ Listserv ❑ Minute Papers ❑

You are free to withdraw from this study at any time without penalty or prejudice by contacting Professor Sparks or Dr. S. Magliaro (sumags@vt.edu), Division of Curriculum & Instruction, War Memorial Hall, Virginia Tech (231-5578). You are free not to answer any questions or respond to experimental situation without penalty. Participants of this project will not be exposed to any risk or physical discomfort.

This research project has been approved, as required by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department. If you have any further questions please contact, Tina Bavaro, Division of Teaching and Learning, War Memorial Hall, Virginia Tech (231-5578) or email tinabav@vt.edu.

1. Indicate on the 5 point scale your level of familiarity with cooperative learning.

LOW				HIGH
1	2	3	4	5

Give Examples ....

2. Indicate your level of familiarity with computer technology.

LOW				HIGH
1	2	3	4	5

Give Examples ....

3. Indicate your familiarity with "hands-on", experiential learning.

LOW				HIGH
1	2	3	4	5

Give Examples ....

4. Indicate your level of familiarity about forces.

LOW				HIGH
1	2	3	4	5

Give Examples ....

5. Indicate your level of familiarity with trigonometry and algebra.

LOW				HIGH
1	2	3	4	5

Give Examples ....

Your signature below indicates that you have read the information above and agreed to participate in the research project. I have read and understand the informational consent questionnaire and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

Signature.....................................   Date...............................

Also, please print your name: ....

Contact Telephone No: .... Email.............................

APPENDIX B

Student Profiles

The following profiles were developed for the John, Lina, Fred, Tony, Jim and Vince who participated in the mid-term and final semester interviews.

• ***John***

Male

1. Mediocre familiarity with cooperative learning
2. Mediocre familiarity with computer technology
3. Mediocre familiarity with hands-on, experiential learning
4. Low familiarity of the concept of forces
5. High familiarity with algebra and trigonometry

• ***Lina***

Female

1. Low familiarity with cooperative learning
2. High familiarity with computer technology
3. High familiarity with hands-on, experiential learning
4. Mediocre familiarity of the concept of forces
5. High familiarity with algebra and trigonometry

• ***Fred***

Male

1. Mediocre familiarity with cooperative learning
2. High familiarity with computer technology
3. Mediocre familiarity with hands-on, experiential learning

4. Mediocre familiarity of the concept of forces

5. Mediocre familiarity with algebra and trigonometry

• ***Tony***

Male

1. Low familiarity with cooperative learning

2. High familiarity with computer technology

3. Mediocre familiarity with hands-on, experiential learning

4. Mediocre familiarity of the concept of forces

5. High familiarity with algebra and trigonometry

• ***Jim***

Male

1. High familiarity with cooperative learning

2. High familiarity with computer technology

3. High familiarity with hands-on, experiential learning

4. High familiarity of the concept of forces

5. High familiarity with algebra and trigonometry

• ***Vince***

Male

1. High familiarity with cooperative learning

2. High familiarity with computer technology

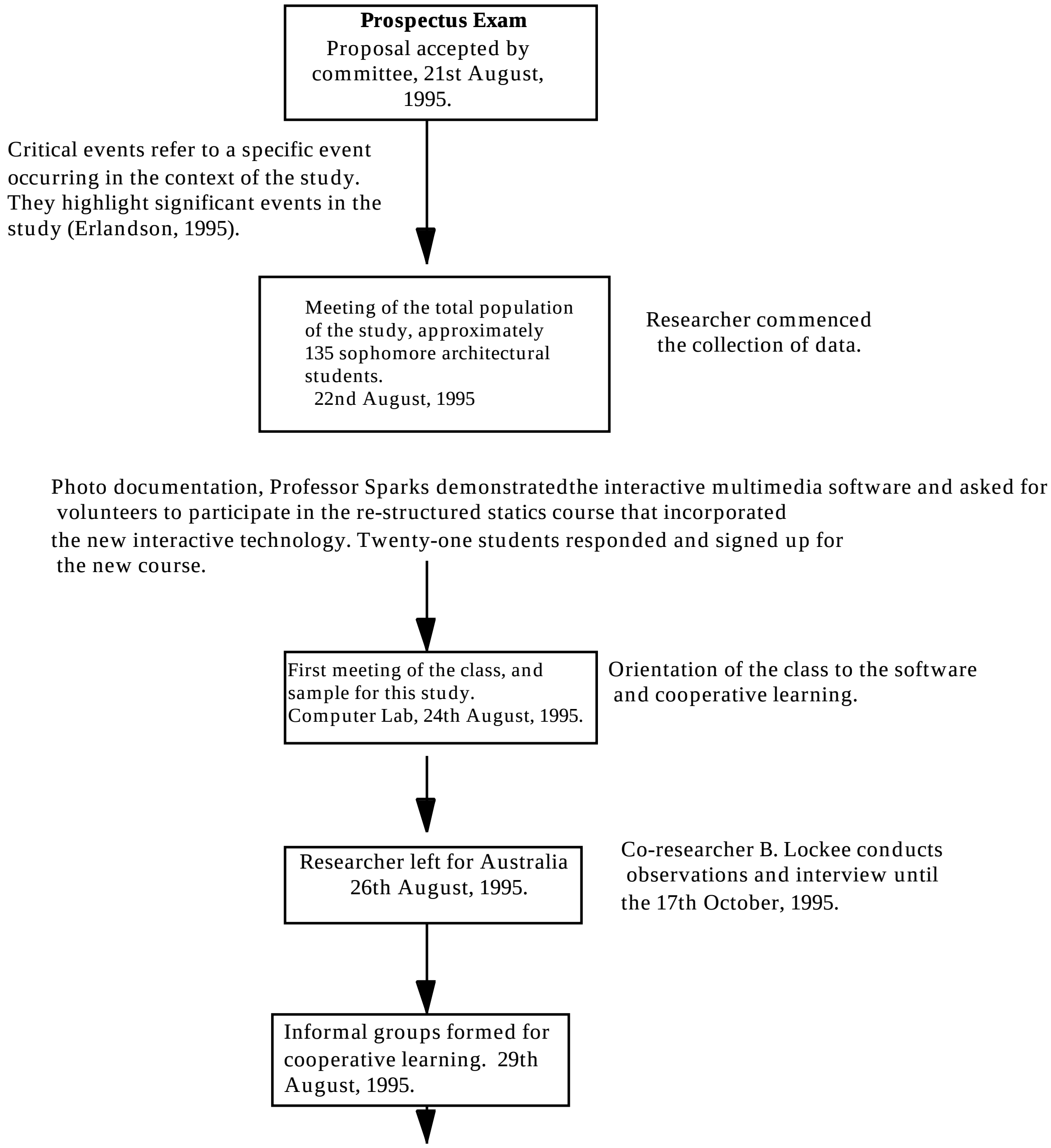
3. High familiarity with hands-on, experiential learning

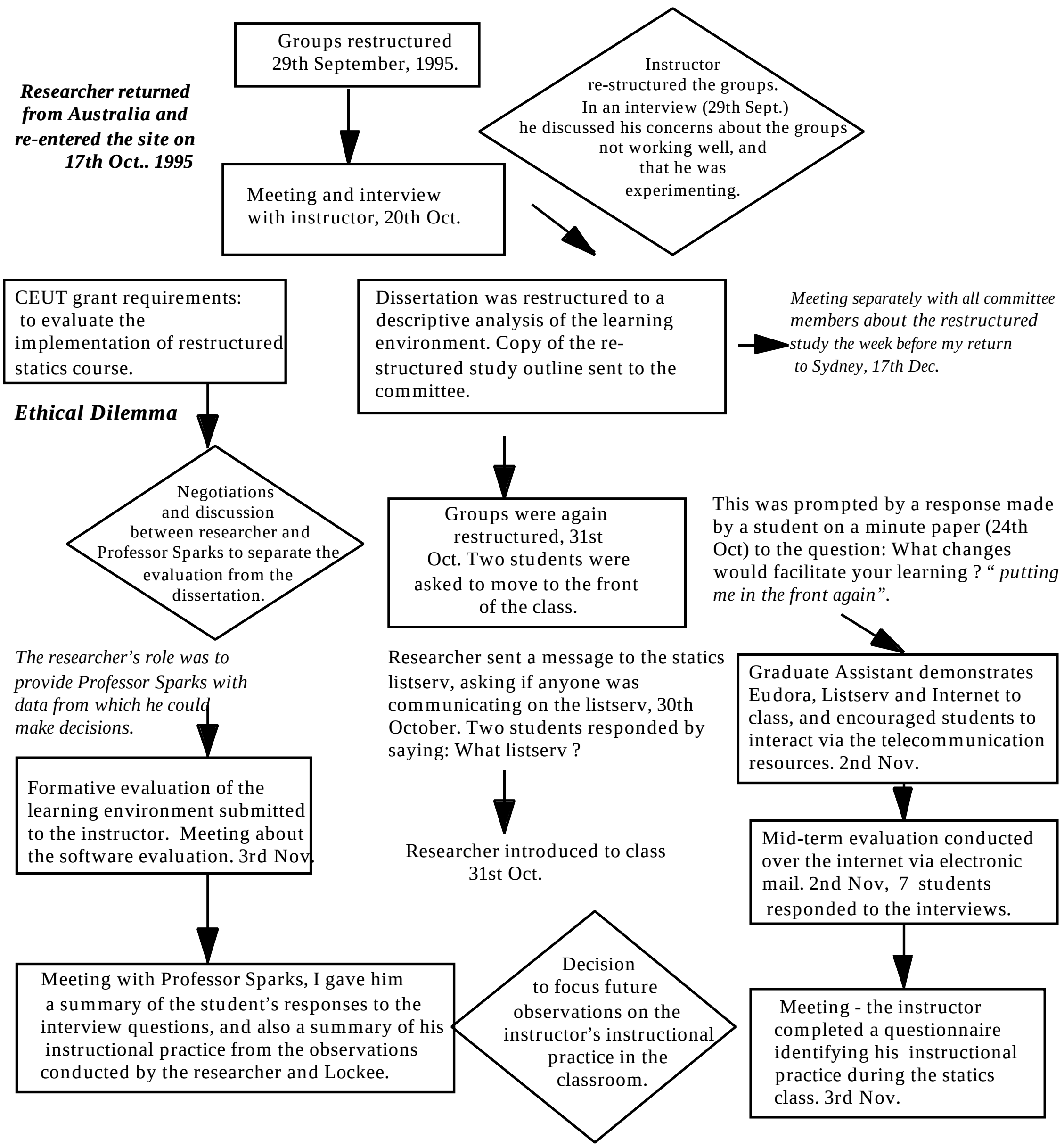
4. High familiarity of the concept of forces

5. High familiarity with algebra and trigonometry

APPENDIX C

Flow Chart of the Critical Events of this Study




Groups restructured 29th September, 1995.
Instructor re-structured the groups. In an interview (29th Sept.) he discussed his concerns about the groups not working well, and that he was experimenting.
Researcher returned from Australia and re-entered the site on 17th Oct.. 1995
Meeting and interview with instructor, 20th Oct.
CEUT grant requirements: to evaluate the implementation of restructured statics course.
Dissertation was restructured to a descriptive analysis of the learning environment. Copy of the re-structured study outline sent to the committee.
Meeting separately with all committee members about the restructured study the week before my return to Sydney, 17th Dec.
Ethical Dilemma
Negotiations and discussion between researcher and Professor Sparks to separate the evaluation from the dissertation.
Groups were again restructured, 31st Oct. Two students were asked to move to the front of the class.
This was prompted by a response made by a student on a minute paper (24th Oct) to the question: What changes would facilitate your learning ? " putting me in the front again".
The researcher's role was to provide Professor Sparks with data from which he could make decisions.
Researcher sent a message to the statics listserv, asking if anyone was communicating on the listserv, 30th October. Two students responded by saying: What listserv ?
Graduate Assistant demonstrates Eudora, Listserv and Internet to class, and encouraged students to interact via the telecommunication resources. 2nd Nov.
Formative evaluation of the learning environment submitted to the instructor. Meeting about the software evaluation. 3rd Nov.
Researcher introduced to class 31st Oct.
Mid-term evaluation conducted over the internet via electronic mail. 2nd Nov, 7 students responded to the interviews.
Meeting with Professor Sparks, I gave him a summary of the student's responses to the interview questions, and also a summary of his instructional practice from the observations conducted by the researcher and Lockee.
Decision to focus future observations on the instructor's instructional practice in the classroom.
Meeting - the instructor completed a questionnaire identifying his instructional practice during the statics class. 3rd Nov.

Electronic mail correspondence with graduate assistants. **No response.**20th Oct.

Sent interview questions via email to Professor Sparks,asking him to clarify his goals for the learning environment. **No response.** 20th Oct.

Electronic mail interview with Professor Sparks to seek clarification regarding his role as a facilitator in the learning environment. 3rd Nov.

Face to face interview with Professor Sparks, and gave him a copy of the student response to the questionnaire and a summary of his instructional and assessment strategies. A copy of the evaluation was sent to Professor Sparks. 17th Nov.

Electronic mail sent messages to graduate assistants -**no response. 17th Nov.**

Meeting cancelled by Professor Sparks, 24th Nov. On the 28th Nov, he told me he had not checked his voice mail to confirm the meeting, and he did not acknowledge the instructional practices.

Meeting **cancelled** by Professor Sparks 6th Dec.

Meeting **postponed** by Professor Sparks 12th Dec.

Meeting 14th Dec, I (researcher) had prepared a December Formative Evaluation Report. Professor Sparks decided not accept the report, but said he would send me an email when he needed the report, Jan. or April, 1996.

As a part of the triangulation process the researcher asked students to also complete the questionnaire and comment on their perceptions of the instructor's instructional practice. 6 students responded, 8thNov.

Instructor commenced relinquishing control, 7th Nov.

Professor Sparks made changes to one of the minute paper questions in order to address the cooperative learning component of the learning environment. See Appendix G.

Professor Spark's designed another questionnaire and distributed it to students on the 5th Dec.

This provided the researcher with the student's perspective of Professor Spark's instructional and assessment strategies.

Divergent views began to emerge regarding the instructor's pedagogy.

Student's commented on the ***"roaming professor".***

Face to face interviews conducted with 5 students and the undergraduate teaching assistant, and 1 student email interiew 1st and 6th Dec.

Observations ceased on 5th Dec.

Bavaro questionnaire sent to students via email, 6th Dec.

Photographs were used as a prompt during the interview in order to clarify his role. His perception was that he was guiding students through a problem solution.

APPENDIX D

Semi-Structured Interview Guides.

These open-ended questions served as a starting point for discussing the restructured statics learning environment.

<u>Instructor</u>

Interview 1

a. What are your goals ?

b. How have your goals changed ?

c. Describe the course.

d. The course has been running for a few weeks, how would you rate it on a scale of 1-5, with 5 being excellent.

e. What do you think students are learning ?

Interview 2

a. What do you see happening in the new learning environment ?

b. How would you describe the nature of the learning environment ?

c. How would you describe your role in the learning environment ?

Interview 3

a. I would like you to talk a little bit about the learning environment that is being created in the restructured statics course, firstly could we talk about your beliefs.

b. Describe the collaborative nature of the environment.

c. Was that conceptualized from someone's work?

d. On your questionnaire you indicated that the learning environment is student focused. Can you explain to me what it actually means ?

e. Identify some characteristics of a student focused learning environment ?

f. Can you describe an example of student focused learning from the restructured statics course?

<u>Students</u>

Mid-Term Email Interview.

a. How would you rate the statics course on a scale of 1 to 5, with 1 being poor and 5 being excellent. Please explain your choice.

b. What are you learning in the statics course ?
c. How do you feel about cooperative learning ? and the group that you are working with ?
d. How do you feel about experiential learning that involves " hand-on" experiments ?
e. If you could change anything about the statics course what would it be ?
f. What do you see your role (as a student) in this new learning environment ?
g. Would you be prepared to participate in another interview ?

End of the Semester Interviews.

a. It's now the end of fall semester, how would you rate (on a scale of 1-5 the statics course ? Why? Please explain.
b. Explain what it was like to be student in the statics learning environment.
c. How does the statics course compare with other courses you have taken this year ?
d. What made you volunteer for this course ? Describe your background.
e. What did you think about the cooperative learning aspect of the class ?
f. What did you think about the experiential learning aspect of the course ?
g. How did you feel about the computers in the learning environment ?
h. Describe the role of computers in the learning environment ?
i. Describe the role of the instructor in the learning environment ?
j. What is your perception of a multimedia learning environment ?

Undergraduate Teaching Assistant

a. Can you explain your role in the learning environment ?
b. What is the main difference between the two statics courses ?
c. What are your impression of the learning environment ?
d. Describe the role of the instructor in the learning environment.
e. Describe the nature of cooperative learning in the statics class.
f. What do you think about the computers in the learning environment ?

APPENDIX E

Bavaro Interactive Multimedia Software (IMS) Questionnaire

Date: Wed, 6 Dec. 1995 12:23:19 -0500
X-Sender: tinabav@mail.vt.edu
Mime-Version: 1.0
From: tinabav@vt.edu (Tina Bavaro)
Subject: Statics- IMS Final Evaluation

Hi everyone !

Thanks for your cooperation and taking the time to chat with me. Remember in the interview that I would send you a IMS questionnaire to complete. Here it is !

(IMS) Interactive Multimedia Software Questionnaire

Directions: The following statements relate to the multimedia learning environment for statics, please indicate to what extent you agree or disagree with them by circling the most appropriate response that closely represents your feelings. Thank you for your participation.

1. I understand the statics problems in the IMS Agree Disagree

Please explain ____

____

2. The feedback I received from the software was helpful. Agree Disagree

Please explain ____

____

3. a)The IMS software is easy to navigate. Agree Disagree

Please explain ____

b)What opportunities were presented to you to navigate through the software ?

____

If the software was not easy to navigate how could it be improved ?
____

4. I felt that the IMS software has assisted my learning in statics Agree Disagree

Please explain, how has it assisted your learning, give an example ?
____

____

5. How can the IMS be improved so that it does assist your learning of statics ?

____

____

6. The screen display is clearly set out. Agree Disagree

Give examples ____

7. Sufficient help and support for my learning has been built into the IMS software. Agree Disagree

Please explain ____

____

8. Having the answers available to me have assisted my learning.
Agree Disagree

Please explain ____

____

9. The software was highly interactive
Agree Disagree

Please explain ____

____

10. Define and describe your perceptions of a multimedia learning environment.

____

APPENDIX F

Professor Sparks' Interactive Multimedia Software (IMS) Questionnaire

December 5, 1995.

Interactive Multimedia Software (ISM) Student Questionnaire

Please reflect on the following statements and mark your response on the scales.

1. Interaction
In group activities, the instructor can only interact with one group at a time; this limitation is alleviated by IMS's constructive feedback.

1	2	3	4
D	TD	AT	A

2. Inductive Approach
The development of concepts and principles (e.g. forces, moments, Newton's laws) and method of analysis (e.g. method of joints for trusses) from concrete examples (e.g. girl on rings, children on seesaw, model of truss) facilitates learning.

1	2	3	4
D	TD	AT	A

3. Deductive Approach
The summaries of concepts, principles, and methods of analysis provide the opportunity for quick reviews and reinforcements.

1	2	3	4
D	TD	AT	A

4. Navigation
It is easy to move around in the IMS and know where you are.

1	2	3	4
D	TD	AT	A

5. Using IMS
I would have liked to use the IMS more:
In class

1	2	3	4
D	TD	AT	A

Outside of class

1	2	3	4
D	TD	AT	A

Please Comment.
1. The IMS is being designed as a learning resource in the classroom and in the student's home to review, review, explore, and reflect on learning experiences. Did the program facilitate learning even though you didn't have a personal copy in your home ? please be specific.

2. What changes should be made to improve the IMS ?

APPENDIX G

Minute Paper Exemplar

Minute Papers

Date:

Please write answers to the following questions about today's lesson and activities.

1. Important point(s) ?
2. Any surprises ?
3. Muddy parts or questions ?
4. What changes would facilitate you learning ?
5. Any concerns ?

Minute papers were proposed by Charles Schwarts, Professor of Physics, University of California. Berkeley. He asked students a few minutes before the end of the class to write answers to two questions: 1. What was the most important thing you learned today ?
2. What questions are uppermost in your mind as we conclude this class today (Cross, Patricia, K. Effective College Teaching, ASEE PRISM, October, 1991, p.29.)

Revised Minute Paper
Professor Sparks.

Date:

1. Important points/surprises ?
2. Questions/suggestions ?
3. Group activities : What are we doing well ? What improvements should we make ?

APPENDIX H. *Teaching Events During the Fall Semester, 1995.*

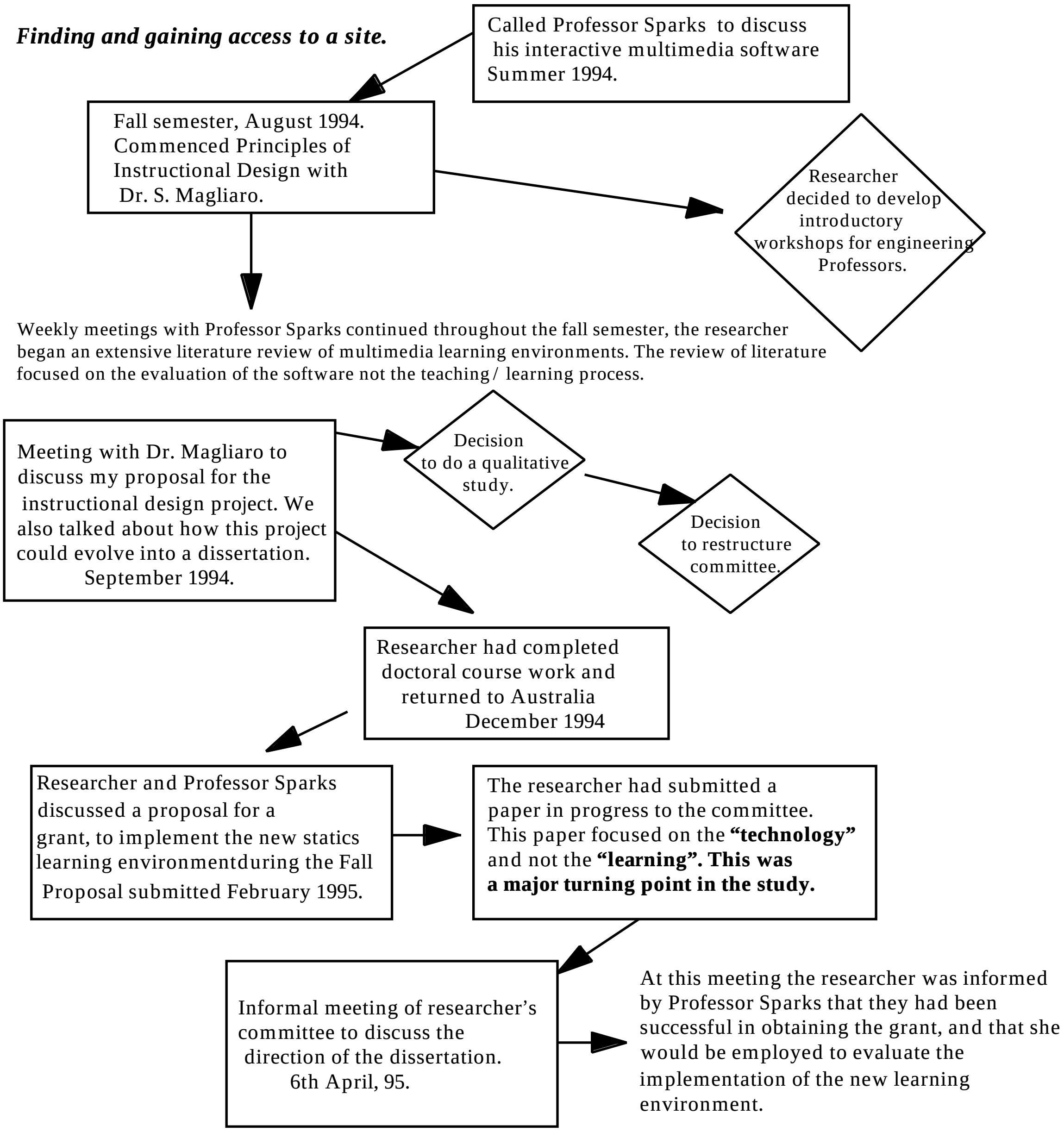
Basic Structure	22nd Aug.	24th Aug.	29th Aug.	31st Aug.	5th Sept.	7th Sept.	12th Se
1. Warm Up Problems Short activity to address problems or questions that surfaced about - homework - weekly quizzes - minute papers - focus on lesson.	3.30 pm Multimedia Presentation -description of workshop environment, - class structure - cooperative learning - minute papers	Introduction to software. Review of cooperative learning strategies. Handout re-cooperative learning distributed to students.	Professor addressed student concerns from the minute papers. He asked students to slow him down if he was going to fast, and if the faster students could help the slower students. O/H Outline, forces, equilibrium, rectangular components, team problem. MPs review.	GA described how to down load the software. Review of minute paper responses. Professor discussed the structure of the class. That is him presenting for 8-10 minutes and then students summarizing their thoughts in groups. He will bring experiments to class.	No data collected at the site. Researcher was unable to collect the data.	Professor asked Dr. Lockee to wait until next week to distribute the consent forms. Re-structuring of groups. Quiz displayed on O/H. 3.45. pm. Quiz completed Instructor distributed the correct solution to students. O/H of objectives for the class. Instructor responded to the minute papers.	Photog photogr statics l Positive respons class. Re-arra Instruct experim
2. Activities Mini lecture interspersed with group activities: - Interactive multimedia software (IMS) - White board - O/H's - Coursepaks, lecture notes with gaps.	Interactive multimedia software -Forces Preview No student response to questioning. Concrete examples from the IMS. Informal groups were formed. Minimal student interaction occurred.	Interactive multimedia software Task - Forces, Newton's First Law. Instructor used the white board to explain mathematical modeling of a problem.	Students formed teams and completed the Interactive multimedia software (IMS) forces tasks. Groups discussed the forces acting on the girl. 4.00pm Commenced team problem. Instructor suggested a method for problem solution ie. one person start by saying how they would go about solving the problem, and others could join in with recommendations. Students became interactive. Instructor monitored the groups. 4.20pm. Professor presented his answer. Use of white board for mathematical explanations of the problem. 4.25 pm. Break. 4.40.pm. Some navigational instructions. Instructor explained experiential learning to the students. He then set and discussed new problems.	3.50pm. Students interacted for 2 minutes when reviewing the previous class problem. IMS used to address students questions about statics, cooperative learning and workshop environment. He discussed how this class was an extrapolation of the old traditional environment, and asked the architects to design a new environment. Commenced IMS Task about rectangular components. Instructor asked if his instructions were clear, and if they could experiment with the feedback component of the program. Students completed the computations. GA provided assistance. 4.15pm. Break. Many students stayed back to use the software. 4.20pm. Instructor explained problem solution. 4.25pm. Vectors discussed. 4.35pm. Graphing vectors.		Explanation of resultant vector computations. Students not paying attention. Professor asked if students understood the concept. No response. Restructuring of groups. Break 4.15. One student refused to move into the new group. IMS experiment. Group interaction, Professor helped one group other group started playing games. 4.40 O/H of the experiment. Group discussion. White board explanation of the solution.	IMS exp Group i problem Handou Student After 3 instruct you the analysis Homew New pr group c explaine
3. Minute Papers	Minute papers completed.	Minute Papers	4.45.pm Students commenced completing minute paper responses.	4.4.5 pm Students completed minute papers. Instructor presented a cartoon about decisive action, and encouraged interaction outside of the class.		Minute Papers.	Minute
Data- Minute Paper comments.		Professor going to fast. Program seems rather self explanatory.	Let us discuss straight way. Professor going to fast. Are we keeping up with the other class? Group member was slow to navigate, causing the whole group to fall behind. I see the connections in class. This session went well. I was surprised how easily the concepts came together. This class went very smoothly and I felt I understood the material a lot better than the last time. I really appreciate the effort you are putting forward. IMS more modeling - physical or software so I can learn. I really don't think you should show us the answers to the homework before we do it. Are we going to see any movies that show forces affecting structures.	Confusion over the terminology. We are not using the computer. I am not sure how the computer program will help our understanding of ideas. I am a little confused by the use of computers, but all that needs is just time. I remain impressed with the knowledge and determination to make this class happen. It is very helpful when I see a process that shows what happens when forces change, like the experiment, so I can interpret and understand. Please Professor slow down. Material was presented too quickly.		I'm sure that we will learn as much as the other class, but I feel we're going to slow. Is it wise to jump in the middle instead of covering the basics first? Best class so far, I learned so much today than any other class. *What changes would facilitate learning ?* Layout of the classroom. It would be better in a circular group arrangement as opposed to linear. The work should be centered dynamically.	Not enc homew

	21st Sept.	26th Sept.	28th Sept.	3rd Oct.	5th Oct.	10th Oct.	12th Oct.
1. Warm - Up Problem	Instructor asked Barbara if he could look over the consent forms. Distributed quiz.. 3.47pm. Students completed the quiz. 4.00pm. Overview of the minute papers.	No data , the researcher was unable to conduct the observations.	Instructor asked for a copy of student consent forms. O / H of class objectives Discussion of quiz using O / H. Instructor explained the problem.	No observational data available.	Instructor explained a simple couple experiment. 3.35 pm. Quiz 4.00 pm. Completion of quiz.	O / H objective for the class. Only 8 out of 20 students submitted homework. New guidelines fro quizzes. Students could no longer use open notes only a crib sheet . Review of previous quiz. Re-doing quiz. Minute paper responses.	No observational data is available.
2 Activities			3.43pm. Team problem O / H screen shot of IMS screen. Some students launched the program others did not use the computer. 3.54 pm. Instructor explained the solution. Instructor discussed the homework. Set new problem. Discussed solution. Discussed different new problems. 4.26pm. Reviewed minute paper responses. Instructor asked to privately talk to the student who made the comment about the IMS.		O / H definition of resultant forces, equations and computations. Set problem, groups began to interact. 4.30 pm groups still interacting. 4.33 pm. Instructor explained the solution on white board. Students were trying to interact during the explanation. Discussion of H / wk problem. O / H of the solution.	Instructor navigated the IMS to moments and explained the problem. Some students experienced hardware problems and were unable to keep up with the instructor. 4.02pm. Overview of homework. Instructor set problem. Students discussed problem. Instructor explained problem through visual and mathematical modeling. 4.20pm. Summary O / H of forces and moments. 4.24pm. New topic- equilibrium. Demonstrated how to navigate the FBD. Set task from IMS. Groups discussed the problem. 4.30pm. Explained the solution to the problem. 4.32pm. Set another problem. Instructor monitored group discussions. 4.43pm. Explained the computations using O / H.	
3. Minute Papers	Students complete minute papers.					4.46pm. Students completed minute paper responses.	
Minute Paper Responses	I still believe that the classroom layout would enhance participation. I learn more when I work out examples problems in class . Much more than mindless examples that are already solved. I don't think the students need to work on computers during class- it only slows us down and we follow what you do anyway. I think only you using the program is sufficient, but I do think the program is useful for students when they are working out of class. In short I think using the computer during class draws away from the material we are trying to learn and bogs us down in keeping up with the computer. I'm afraid people are getting lost. I'm not sure if you can afford the time in class, but it might help if for each point you ask a few random people questions. Make sure everybody has completed one step before going on to the next.			I got a lot out of today's lesson. It really helped when you walked around the class. This class went well. The roaming professor helps out a lot too.	I realize how much more I learn when I help people learn.	Your choice to re-do the quiz really helped me. Before I was confused about many things on the quiz, but by revisiting it and getting a second look I really picked things up. Not only do I think I got the numbers, but this time I really understood what was going on. Thank you for the second opportunity. As the semester continues I am realizing the importance of working in groups a part of the learning process.. It's so nice to see so much concern for our understanding of the material. I am taking in the information quickly. I leave confused about something.	

	24th Oct.	26th Oct.	30th Oct.	3rd Nov.	7th Nov.	9th Nov.	14th Nov.	16th Nov.	28th Nov.
1. Warm up Problem		Test	Students collected mid term exam papers. Instructor restructured the groups. Two students had dropped the class. I was introduced to the class. O/H outline of the class objectives. Distributed solution to mid term and discussed them.	Eudora and Netscape demonstration by GA.	3.20pm. Distributed homework. O/H objectives for the class.	3.30pm. Handed back homework. O/H objectives for the class.	Presently, no observational data available.	Presently, no observational data available.	Quiz distri
2. Activities	Many students were absent today because of a special lecture. I asked 3 students to complete the consent forms. Instructor distributed homework solutions. Instructor asked students not access the computer games in class. Quiz Discussion about bicycle wheel and equilibrium. IMS demonstration of equilibrium and FBD. Instructor navigated through the software and student followed. Further demonstrated with the use of an animation. Students worked on problem and constructed a FBD. Hardware problems with the instructors machine. Demonstration of experiment. 4.15pm. Break. Continuation of experiment while GA fixed the program from the server. Students worked from the IMS individually or in pairs. Instructor moved around the room.		Distributed solution to quiz. Instructor explained how to solve the problem. O/H of grades for the mid term. 12 out of 17 are in the "A" range. Discussion of handout on supports, conducted an experiment. Discussion of homework, computations on the white board and O/H. 4.15pm. Break. 4.20pm. Demonstrated another experiment. Posed questions, no response from students. IMS demonstration, instructor navigates through equilibrium.. Students were asked to compute the problem. Professor monitored and assisted groups. Demonstration of IMS feedback and question mark on the screen.		Launched IMS to review previous class a problem about projections. Students started to interact to solve the problem. O/H new problem, some students are paying attention others are exploring the IMS. Instructor continues to solve the problem, asking students to respond. Students draw an FBD. Before students complete the task, the instructor completes the solution on the white board. Use of the door as real life example and experiment. 4.10pm. Instructor leaves the room. Two students started to check Email and Netscape. 4.15pm. Demonstration of experiment. Student complete handout problems. Students asked questions and instructor moves around the room. This continued until the end of lesson. O/H problem, students spent 5 minutes to complete the solution and class was dismissed. Instructor said : We didn't get as far as I would like to, but that all right.	Navigated students to IMS reactions. Students tried to follow. Posed questions. Demonstrated experiments. Explained problem using the IMS and white board. Monitored students working on the problem. O/H of new problems. Posed questions about problem solution. Students still working on the problem. Demonstrated and experiment and discussed the analysis of structures. Students refer to handouts sheets. Continue working on problem with the assistance of instructor.			Instructor plane struc examples a Discussion learning. Instructor s that next y this course would be a experimen Demonstra experiment Students w from IMS. jumped ah Students w in the task, take a brea continued 4.20pm stu working o explained s white boar continued problem fr the end of t
3. Minute Paper					Discussed changes to the minute papers. Q3 about cooperative learning.				
Minute Paper Responses.	Good to get back to computer work. Doing a good job.				It seems like we have gotten away from many group discussions and questions. We need to work in groups more often. I think it would help a great deal to get together outside of class. A lot of times in class things get forgotten, slows things down. If we met at other times I don't think it would move a slowly. It seems like we have gotten away from group discussion and questions. We find each others mistakes. Give us longer to work on problems. We need to work in groups more often. Allowing more time to work together to answer questions. Improvement - better work area, its difficult and uncomfortable to do all the work on your lap. The area is crowded and not everyone in the group can use the computer. I find it very difficult to work in my group with this setting set up.	Could you really slow down when explaining. More computers.	Good to give handouts and get us to talk. More computer stuff. The demonstration or visual aids really help in demonstrating the way forces are applied.	I'm glad you came around to help. I learned more with this quiz and your help than I would have without your help. Thanks.	

APPENDIX I

Historical Background to this Study



Summer 1995, (June, July, August) researcher began another extensive literature review into social constructivism, Vygotsky and Tharp and Gallimore's model of teaching as assisted performance.

↓

Prospectus exam was scheduled for the 21st August, 1995.
Topic : How students learn in an interactive multimedia learning environment that incorporates collaborative and experiential learning ?

APPENDIX J

Syllabus for New Statics Learning Environment

Policy and Guidelines

Honor Code:
You are bound by the university honor code; it is your responsibility to know the code and the risk of violations.

Grading Basis:

Exam 1 (Oct. 12)	100
10 Quizzes	150
Final Exam (Tu., Dec. 12, 7.45-9.45 pm)	150
Homework	50

Quizzes: Quizzes will last approximately 15 minutes each: an unexcused absence from a quiz counts as a zero; the lowest score will be deleted.

Quiz dates: Sept. 7, 14, 21, 28; Oct. 5, 19, 26; Nov. 2,9, 16, 30

Homework: It doesn't matter how you construct your knowledge. You may seek help from anyone. However, the final work has to be yours. Don't copy ! Generally, late homework will not be accepted.

Course Average	100-90	89-80	79-70	69-60
Minimum Grade	A	B	C	D

Your final grade may reflect additional factors such as your performance trend, teamwork, class participation, and attitude.

Suggestions for Meaningful (and Efficient) Learning:

- Work with me and your teammates in class: If you need help, let me know.
- Review your class notes as soon as possible: What was the objective of the lesson and what were the major points ?
- Do your homework as soon as possible: At least outline the solution and raise questions: How does it work and why does it work ?
- Prepare for the day's lesson.
- Spend a few minutes before each lesson to review the previous lesson; prime your mind.

APPENDIX K

Mid Term Ranking of the New Statics Learning Environment

Students were asked how would you rank the statics course, on a scale of 1 to 5, with 1 being poor and 5 being excellent.

Student	Rank	Comments
Fred	5	I think that Professor Sparks is an incredible teacher in a difficult class. Statics is not easy and he ma that the material is understood before he moves on to the next part.
Tony	4	I find that the material in the course is very stimulating and Professor Sparks uses the handouts and c well together. I am not sure that the computers are showing a lot but I enjoy being able to interact w problems.
Lina	3	Professor Sparks is a really good professor, but I think that the computers are taking away from this computer, could be made more accessible to me and as easily as grabbing my book for reference, I th would be much better. I think the interactive environment is a great idea, but it seems that time runs questions are left unanswered in the classroom.
John	4	I think that I'm learning things 'deeply' but it is sometimes frustrating to me that we keep going ove things. I suppose that it is because we all learn at different speeds. It deserves a 4 because it is fairly casual, easy to talk and ask questions in etc. There was one day when I asked about a moment in a pi he explained and fretted that we wouldn't understand, but I did understand and I want to do more thing
Jim	3	I would give it a 3 right now. Granted they (computers) do provide a good learning engine, but past t learning of the general concepts they are a fifth wheel.
Vince	3.5	The course doesn't seem to be real organized yet. I think that's normal with a first year experimental
Professor Sparks		From the instructor's perspective, when Professor Sparks was asked in an interview (29th Sept. to ra class he said: 16 out of 20 are "A" work. These grades were also reflected in the mid term results (31s observations).

APPENDIX L

Final Semester Student Ranking of the New Statics Learning Environment.

Student	Rank	Comments
Fred	5	He's excellent. His whole attitude is really great. He gives you a chance to do it, and if you don't und of time explaining it. he really goes back and spends a lot of time explaining it to you. It's really a g that's because of the computer. I have a feeling its more because of Professor Sparks. Because he's ju confidence in you and working with smaller groups is easier than working with huge groups where y time to put into it in class, but I think in the long run its more exciting than a lecture and...you just l learned it's just I pick up everything well and really quickly and what I don't pick up comes from, if I he's done a really good job presenting the information and giving us a chance to work on it. I think t it tends to be a little slow. But I'm not going to, you know you have to go at the pace of everyone el
Vince	3.5-4	I wouldn't go 5 because I think there is a lot of potential but for the course that hasn't been taken yet
John	4.5	I think it's really worthwhile, and I really think you are going to understand more about statics in th
Jim	3-4	I mean it's a good course. But as far as the integration of the computer it seems to be somewhat lacki because its the first year this course has been implemented and that improvements are being made al
Tony	5	I guess it would probably be a five. I mean I really enjoyed the material, and almost any way I can g Professor Sparks was able to introduce it was that much better. Just because he was very open to stuc
Lina	3	Three is a mediocre response to the mediocre learning environment. It was relatively unorganized an Although, I like the team effort in class, I think if I would have a copy of the program on a computer outside of the class, I would have done better. Even better with the team in class. I had no base to go book did not help because a lot of the problems were solved in a different way and that confused me r packet of handouts that followed the program that could have made a difference. The physical setup c able to see the professor and things he may be pointing out are just as important as what is on the co numerical label does not fit Professor Sparks, as he is a good teacher and seems to be quite fair in tre
		Final Grades ESM 2705 4- A, 4-A-,2-B, 1-B+,1-B-, 2-C+ ,1-C, 1-C-, 1-D-

APPENDIX M

Mid Term Student Cooperative Learning Comments

Student	Cooperative Learning Comments
John	Cooperative learning is I think a pretty good system though, I think also that the Professor teaching should monitor what is going on. The group I'm working with is pretty good. I'd like to think that I am helping them when they ask questions. One of my group members has trouble multiplying without a calculator and also with basic addition. I think that these are serious problems and that they need to be addressed. Probably not in class but it needs to be dealt with.
Lina	I think it would be a very effective learning tool only, if the environment is truly made available to the students. As it is now, it is a half attempt. It is not the professor, but the setup of the class that needs improvement. Then everything else should fall in place.
Jim	I preferred working in the group that I was with at the beginning of the class. We all seemed to strengthen each other, not only because each other well (John & Tony), but we knew each others schedules and that really seemed to be the basis for how strong our group was.
Vince	I think it's working fine, it is definitely a help to understanding the concepts. Some of us have also used it outside of class, and it's worked really well.
Fred	The whole idea of cooperative learning is a great method of teaching. It works in that things can sometimes be explained better coming from your peers and a group situation. The groups I have been in are and have been great. I think that it takes the boredom from the class because you are working with other people not just scribbling notes as fast as you can.
Tony	I am finding that I learn a lot more when I have to explain myself to others. The group that I am in is fine. But I think that sometimes they just accept answers instead of truly understanding them.

APPENDIX 0

Mid-Term Student Experiential Learning Comments.

Student	Mid Term Comments
John	Experimental learning is what make things come together for most people. I think that a physical example right in front of a person that they can interact with is the ultimate in teaching abstract concepts.
Lina	We have not really done any “hands on” experiments. I enjoy real experiments where you can actually see, for instance, weights pulling on a cable as it actually happens. I feel somewhat removed from this realness by only looking at a diagram on a screen and then clicking a button. I sometimes feel a lot of experience gets lost in this computer environment.
Jim	I think that “hands-on” learning is the only way to learn.
Vince	I think those are some of the best ways to learn concepts. If you can see it, experience it, then it becomes easier to comprehend.
Fred	I think it has to go along with the cooperative learning aspect of the class. Statics is difficult in the visual understanding aspect of the problem. without the experiments there would be an even larger number of people who would be lost.
Tony	No data available.

APPENDIX P

Final Semester Student Experiential Learning Comments.

Student	Final Semester Comments
John	For me watching Sparks do those experiments I can figure out what's going on. I think ideally it should be what's suggested so far where there's a group and every group has that experiment where they can literally interact with it. That's what he is planning to do and I think that's what needs to be done.
Lina	I am glad to see the use of computers in a classroom directly. I was apprehensive at first that it would take away from the professor/student relationship. I have always had good relations with my professors, I suppose that I projected a barrier would result from this type of environment. However, this barrier did not come up. I do believe that, instead of focusing on the computer and the development of the program, that there should be have been more consideration on more physical aspects of the class, like the set up of the desks/computers/groups...
Jim	No data available.
Vince	Hands-on experiments are a great way to learn.
Fred	I think it is a good idea. I think the more lab like set up he has the less things, the more time he's going to need to really explain things. Because if it's a total lab environment where you do an experiments on these things, if he could make them short and quick and not dwell on that aspect too much. Because it helps visualizing it if you can see it. But there's some things like a cantilever that no matter how many times you do the experiment it's not going to help you unless you really understand what's going on before. So plus a lab can really get drawn out.
Tony	There were a couple of models that he did have but it wasn't something that each person used. It had to be something after class... and I think the computer tried to do that a little bit...I guess I kind of find that as a luxury. Because I know that in my high school they tried doing that a lot and it just expensive.

APPENDIX P

Final Semester Student Experiential Learning Comments.

Student	Final Semester Comments
John	For me watching Sparks do those experiments I can figure out what's going on. I think ideally it should be what's suggested so far where there's a group and every group has that experiment where they can literally interact with it. That's what he is planning to do and I think that's what needs to be done.
Lina	I am glad to see the use of computers in a classroom directly. I was apprehensive at first that it would take away from the professor/student relationship. I have always had good relations with my professors, I suppose that I projected a barrier would result from this type of environment. However, this barrier did not come up. I do believe that, instead of focusing on the computer and the development of the program, that there should be have been more consideration on more physical aspects of the class, like the set up of the desks/computers/groups...
Jim	No data available.
Vince	Hands-on experiments are a great way to learn.
Fred	I think it is a good idea. I think the more lab like set up he has the less things, the more time he's going to need to really explain things. Because if it's a total lab environment where you do an experiments on these things, if he could make them short and quick and not dwell on that aspect too much. Because it helps visualizing it if you can see it. But there's some things like a cantilever that no matter how many times you do the experiment it's not going to help you unless you really understand what's going on before. So plus a lab can really get drawn out.
Tony	There were a couple of models that he did have but it wasn't something that each person used. It had to be something after class... and I think the computer tried to do that a little bit...I guess I kind of find that as a luxury. Because I know that in my high school they tried doing that a lot and it just expensive.

APPENDIX Q *Student Responses to Professor Sparks' Interactive Multimedia Software (IMS) Questionnaire.*

	DISAGREE	%	TEND TO DISAGREE	%	TEND TO AGREE	%	AGREE	%	
1. Interaction	0/15	**0**	1/15	**6.7 %**	10/15	**66.7%**	4/15	**26.7%**	When Professor Sparks was b students could go on explorir
2. Inductive	0/15	**0**	0/15	**0**	4/15	**26.7%**	11/15	**73.3%**	No comments
3. Deductive	0/15	**0**	1/15	**6.7%**	7/15	**46.7%**	7/15	**46.7%**	No comments
4. Navigation	0/15	**0**	5/15	**33.3%**	5/15	**33.3%**	5/15	**33.3%**	The program is still much too potential to actively engage pa where you were in the progran clear in this regard but you ha The nature of multimedia is dy I learned more quickly and unc taught on the board then what concentrate on what I was try take to go through the progran easy to follow.
5. Using the Interactive Multimedia Software (IMS) A. In class B. Outside of class	0 1/15	**0** **6.7%**	3/15 1/15	**20%** **6.7%**	5/15 4/15	**33.3%** **26.7**	7/15 9/15	**46.7%** **60.0%**	It helped a great deal in class, when I'm having a problem or
6. Did the Interactive Multimedia Software (IMS) facilitate learning ?							15	**100%**	Yes, (the Interactive Multimedi structure gave the professor a This class has definitely made things are modified and the pr this type of education. I believed that the computer pr trusses as it showed the forces the better. I believe that more extremely helpful. I think that the Interactive Mul with the class. So far so good. Interactive Multimedia Softwar I only wish I could take next s lecture hall for Strengths. The (Interactive Multimedia So reinforce concepts that were ta diagrams) (free body diagrams useful.

APPENDIX R

Multiple Realities of the Interactive Multimedia Software

Student	Comments
John	Well it's a computer environment where you interact with the program. And that interaction consists of you solving the problems or asking questions and then the program will correct you or give you a definition ... So through your exploration of the program you learn statics. (Interview, 1st Dec.)
Lina	If it can be done in a good, easily accessible environment, I think this could be a way to educate in the future.(Interactive Multimedia Software (IMS) questionnaire 12th Dec.)
Jim	Multimedia means to me everything. We live in multimedia (sound, written word, computers, video, conversations) This is true multimedia and also true learning. (Interactive Multimedia Software (IMS) questionnaire 12th Dec.). It's true that you can say that in Spark’s class is multimedia. because it uses computers, it uses calculators but there quizzes given on paper. But in a sense it is a true multimedia course. But it just doesn't seem to lend itself to my interpretation of the word very well.
Vince	I would describe it either as one that involves the computer, demonstrations by the professor, hands-on experiments, and in class instruction, or as a computer program operated as a text book , a virtual lab, and an instructor. The second would use more than just pictures; any textbook does that. It would include animation's, interactive pictures, possibly sounds. It might even go so far as to include videos of examples of teaching and instruction, such as the teacher giving a lesson or demonstration. (Interactive Multimedia Software (IMS) questionnaire 12th Dec.). Well, people today think that it’s just sitting in front of a computer with some software. Which it really, that shouldn't be it. That's only one medium... I think a multimedia learning environment would be...you night have the computer and you might be working with that, maybe you'd be able to set up your own demonstrations. I know in the Physics lab that's something that really helped me learn was the fact that I was actually doing, I was actually witnessing it. It was not just a fact from the book that I took down, it was something I had to see to figure out for myself. (Interview, 1st Dec.)
Fred	A tool much like a textbook but more advanced and safer fro trees, not a replacement for people teaching people. (Interactive Multimedia Software (IMS) questionnaire 12th Dec.). Well I think I was kind of wondering about the multimedia thing earlier it seems to be by multimedia it tends to be more like you learn with the computer that's one media and you learn on paper that's another and then you learn by him teaching that's another. So I would probably in that you use the computer to understand what's going on and you see the professor to reinforce what you think you know that the computer if you're not sure because ... you can always rely more on it seems to me what he says than what's really in the computer. (Interview, 1st Dec.)
Tony	No data available.

APPENDIX S

Student Comments About the Interactive Multimedia Software (IMS)

Features	Student Comments
Content	I may not have the best grade in the class but I fully comprehend the topics covered in class. The (statics) problems in the interactive multimedia software (IMS) are challenging but when you go over them in class with your professo Usually I have no problem, but when Professor Sparks wants us to work on the assumption that positive forces are in tension and negativ overall very clear. I've done physics before, so most of the subject matter covered was nothing new for me. I had no real difficulty with the problems. The interactive multimedia software (IMS) would have been much more useful and understandable had there been a reference of some typ There were many times when the team was just finding the one problem and discussing it when the professor would be going to the next. The problems in the interactive multimedia software (IMS) are challenging but when you go over them in class with you group or Profess
Navigation	The software is easy because if you want to go on you can and if you need to go back the pull down bars will take you exactly where you I found the pull down menus much easier to navigate than the arrows at the bottom. The software is easy to use because if you want to go on, you can and if you need to go back the pull down bars will take you exactly wh I think that by having the pull down menus that have every sub heading, it would be much easier to navigate than the current system whe button. Sometimes it seems easy, and sometimes I have no ideas how to get where I need to be. I found it difficult at times to keep up with the professor. Sometimes it was a little confusing. A lot of the times, what we'd do is look at the top of the screen where they'd have the word slash and times what would happen is when they'd get to a certain level it wouldn't break down anymore and so you'd just have to kind of jump aro think, I guess, I thought about that a little bit just how many steps are you actually taking from the main menu. And sometimes it would confusing. But, I think as long as you stayed with the class it wasn't a problem. And the problem would kind of tell you what it was doin would go forward, it would tell you how many more steps it was. The software is somewhat confusing, mainly because it is slower on some computers than others. Often the teacher's computer would be model. It was very difficult to navigate through. Most times, once the team figured out what the professor was discussing, it was time to move on user friendly and should not require that the professor stops to help students figure out where they are going.
Screen Design	Usually, there is a good balance between the graphic image and text problem. The illustrations are excellent !!. Very informative and easy to understand and discuss with classmates. The computer program illustrations seem to be more 3 dimensional in explanations. Very helpful. With the computer modeling the program does a little bit especially with the free body diagrams it helps you really see a little easier when around. Its a little quicker than drawing it out and re-drawing. So actually in the visualization a lot better. So I like it in that aspect. The program is organized in the layout. Sometimes there are conflicts with the added note windows but they are rare. Just as long as the covered by a help window that is explaining the problem then the windows are helpful.
Feedback	I agree the feedback of the program is helpful. The program is designed to show what you did wrong visually with movement. The whole program makes it a better program. The program is designed to show what you did wrong visually with movement. In most cases the feedback was extremely helpful and illustrated well in both words and pictures what was going on. I found the diagram ones. This may sound elementary, but I really liked the ones that moved because it actually showed how the forces would move. The answer key- I don't think that is a very good way to do things, because you could have absolutely no understanding and get to the sa understand I suppose that it could help. In that they may be able to work backwards to get to the process. It helped to know that I had done a problem right, then I could look at what I did and understand how I got there. Not having the answe answer was correct, and wouldn't let me know if I was doing something wrong. It doesn't seem very worthwhile. By having the boxes for answers really works so that it checks you because you can not know, and just click answer and all is given to y I still find it kind of annoying, if you type in the answer it doesn't make any difference what you type in. Its not totally interactive yet. The (IMS), it appears to be more of a skeleton for something great at this point. It does not have enough meat to it
Interactivity	Well, you had the ability to move things around on the screen. And there were, like a lot of times, they would have like hot words where definition of that word. And, it wasn't just that you find something like that. It would follow you through the whole thing., and it would g like across the menu bar at the top. It would give you the ability to go basically anywhere in the program. And so it gives you a lot of fle It was much more interactive than just taking notes. It's not totally interactive yet. But like some of the animation's and things like that they have now really seem to help a lot. Just recently the that was in doing free body diagrams he would always do unknown forces in a positive direction. And so that way he said positive is al but that's not always the case. That confused me, even though I understood what was going on because the way I had worked on problem force already and then when I worked out the problem, if it was positive I knew it was a compressive force simply by figuring that the we The way that he did it was that it would be positive and then if you worked out the equation and you ended up with a negative number th messed me up because it would be negative as compression or positive as compression and things like that. Its like the program essentially body diagrams in the positive direction. The software was not highly interactive but it was integral to the way that Professor Sparks tried to teach.

APPENDIX T

Changes to the New Statics Learning Environment.

Student	Mid Term Comments
John	I would change the layout of the learning space. I would prefer if students were taught a little more one on one. Thus students who really understand can go further and those with problems can get individual attention.
Lina	The layout of the room should be better to allow each student to see the professor without difficulty, each member to have access/see what is on the screen and still have a place to take notes, more time to digest what is on the screen and to explore during class, more moving diagrams with more time to carefully observe and take notes in class while the professor is still available for questions, access to the program from other computers on campus.
Jim	I would change the number of computers to one for the teacher, and if possible a version of the software should be designed for Macintosh computers because that is the type that the College of Architecture uses.
Vince	I guess I would like to see us either use the computer, or don't , not all this switching back and forth. Jumping from teaching style with no apparent set pattern makes it a little more confusing.
Fred	Possibly larger group projects, not many but every now and again it would give people a chance to work with 4-5 people instead of just your one partner that has been the same for most of the semester.
Tony	Maybe the layout of the lab for more desk space.

CURRICULUM VITAE

M. TINA BAVARO

18.9.1957

Academic History & Qualifications

Tertiary

1996/5/4/3	**Doctoral Candidate** **Instructional Systems Development** Virginia Polytechnic Institute and State University. Coursework included: Interactive Multimedia Development. Telecommunications. Database Management Systems. Principles of Instructional Design.
1992-90	**MASTER OF EDUCATION** University of Sydney. Coursework: Curriculum Studies. Research Studies.
1989	**MASTER OF EDUCATION** Institute of Education (by Thesis).
1980	**BACHELOR OF EDUCATION** Sydney Teachers College A Distinguished Practicum Record.

Secondary

1970- 1975	**HIGHER SCHOOL CERTIFICATE, 1975**
	SCHOOL CERTIFICATE, 1973 Macarthur Girls High School.

Professional Experience

8/95	**VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY, USA.** Researcher Pilot Project: Evaluation of a new engineering multimedia learning environment.
5/95	**VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY, USA.** Providing instructional support at the Faculty Development Workshops. An initiative to encourage faculty to incorporate technology (particularly, computers) into the teaching/learning process.
94/95	**VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY, USA.** Graduate Assistant - Newman Library, Electronic

Reference Area.

8/93 **VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY, USA.**
Graduate Research Assistant- Technology Education.

1/93 **NSW DEPT. OF SCHOOL EDUCATION**
Curriculum Directorate
SEO 2, Senior Curriculum Advisor , TAS (Technological and Applied Studies K-12).
• Managed the " Seeking Challenges for a Technological Future" Project.
• Providing advice on the National Statement & Profiles, TAS curriculum development and implementation.
• Planning and delivery of workshops.
• Preparation of submissions.
• Writing and editing of support documents.

UNIVERSITY OF WESTERN SYDNEY (Nepean)
Faculty of Education.
Lecturer/Tutor for DATTA (Design & Technology Training Agents Project).

Professional Development Courses.
Lecturer, Computing Studies.

2/92 **NSW DEPT. OF SCHOOL EDUCATION**
Curriculum Directorate.
SEO 2, TAS.

Macarthur Girls Technology High School
Parramatta.
Research Project.

UNIVERSITY OF WESTERN SYDNEY (Nepean)
Faculty of Education
Department of Professional Studies
Lecturer/Tutor Part time appointment Semester 1.
DATTA Lecturer/Tutor, Semester 2.

2/91 **UNIVERSITY OF WESTERN SYDNEY (Nepean)**
Faculty of Education
Department of Professional Studies
Lecturer,Part time appointment Semester 1.

UNIVERSITY OF SYDNEY
P/T Supervisor Of Practicum (May-June).

EDUCATIONAL CONSULTANT to :
AMLC, Australian Meat & Livestock Corporation
Board Of Studies

Powerhouse Museum
Rigby Professional Development Centre
Catholic Education Office, Coffs Harbour.

2/91 to 2/90 **UNIVERSITY OF SYDNEY**
Faculty of Education
Lecturer.

1989 **DEPARTMENT OF EDUCATION**
Whalan High School
Head Teacher, List 2
The role of the Head Teacher included:

- Supervision of staff.
- Policy Development for the Faculty:
  - † Staff and Supervision Policy
  - † Resource Policy
  - † Evaluation and Assessment
  - † Computer Policy
- Curriculum Development
- Promotion of Technology at school, community and regional levels.
- Education Business Links School Coordinator.

2/88 - 4/88 **DEPARTMENT OF EDUCATION**
Studies Directorate
SEO1, Curriculum Consultant.
Seconded to the Studies Directorate as Curriculum Consultant.
Reporting to the Director, the role incorporated:

- Participation at syllabus meetings
- Planning of workshops
- Preparation of submissions.
- Writing and editing of support documents.
- Professional Development.
- Staff Development Participation.

Teaching Experience

5/95 **VIRGINIA POLYTECHNIC INSTITUTE & STATE UNIVERSITY, USA.**
Providing instructional support at the Faculty Development Workshops.

93/92/91 **UNIVERSITY OF WESTERN SYDNEY (NEPEAN).**
Part time Lecturer, Tutor.

1990 **UNIVERSITY OF SYDNEY**
Lecturer.

2/89 to 2/90 **WHALAN HIGH SCHOOL**

	Head Teacher .
1983 to 1988	**MALVINA HIGH SCHOOL** Assistant Teacher, PEP-Participation and Equity. Program Co-ordinator, Student Advisor.
1988	**Relieving Head Teacher**
1985	**Acting Head Teacher (November/December)**
1980 to 1982	**DOONSIDE HIGH SCHOOL** **Assistant Teacher**

Memberships

Association for Educational Communications and Technology, AECT.
International Technology Education Association, ITEA.
Australian Academy of Design, AAD.
International Visual Literacy Association, IVLA.
American Educational Research Association, AERA.
Eastern Educational Research Association, EERA.
Design in Education Council of Australia, DECA. (Former Treasurer).

Presentations

3/95	ITEA (International Technology Educators Association) Conference Nashville, Tennessee, USA. Constructivism: Implications for Design & Technology. Panel Discussion: International Perspectives of Design & Technology.
2/95	EERA (Eastern Educational Research Association) Conference Hilton Head, South Carolina, USA. Crafting a model for a multimedia learning environment.
3/94	ITEA Conference. Kansas City, Missouri, USA. Co-presentation with Lyn Peacock.
6/93	Association of Independent Schools, TAS Issues Seminar. Seeking opportunities and meeting challenges for a technological future.
1992	Primestep Inservice. Assessment and Evaluation of Science & Technology K-6 Syllabus. John Paul 1, Coffs Harbour. Implementing Design & Technology Yrs 7-10.
1989	Institute of Education, University of Sydney. Education Business Links Program Lecture.

Publications

NSW Department of School Education. (1993). Curriculum Information Package : Design & Technology Yrs 7-12 " Seeking Opportunities & Meeting Challenges for a Technological Future".

NSW Department of School Education. (1993). Primestep - Assessment & Evaluation for the Science & Technology K-6 Syllabus.

Bavaro, M.T. (1991). The use of computers as a tool in Design and Technology Journal of the Design in Education Council Australia. (2),Sept.

Bavaro, M.T. (1992). Resources for teaching Design and Technology . DECA Conference Proceedings.

Dept. Of Education/SBS Video Production. (1989). Computers Across the Curriculum.