



Predicting prospective teachers second- or third-wave achievement on a computer based lesson planning task using cognitive and affective measures
by Christine Hesperen Lamb

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Education
Montana State University
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Abstract:

Instructional computing is at a crossroads, searching for the appropriate place for the computer- in the classroom. In one classroom, the computer is the object of instruction or a supplement to traditional instruction (second-wave). In another, the computer is an integrated part of the content area and a means to teach information processing and reflective judgment (third-wave).

Research suggested that the choice of one approach over the other is related to the following factors: teachers' anxiety about technology and teachers' epistemological view of information processing and learning.

The problem of this study was to determine the degree to which prospective teachers' second- or third-wave achievement on a computer-based lesson planning task could be predicted from knowledge of the following set of variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. Level of epistemological maturity was based on a measure of the Perry Scheme of Cognitive development; level of computer anxiety was assessed using a computer attitude scale. Achievement was assessed on a computer-based lesson planning task designed by the researcher and the course instructor to measure both the type and the degree of integration of computer applications into prospective teachers' instructional planning. Participants in the study were prospective teachers enrolled in Montana State University's required teacher preparation computer course during Autumn quarter 1987 or Winter quarter 1988.

Regression analyses indicated that epistemological maturity and age were significant predictors of second- or third-wave achievement. Approximately 35% of the variance in achievement could be accounted for by level of epistemological maturity. Level of computer anxiety was not significantly correlated with achievement.

Based on the analyses, the following conclusions and recommendations were drawn. In the affective domain, it was suggested that less time should be spent in pre-service education addressing issues of computer anxiety and more time should be spent promoting epistemological maturity. In the epistemological domain, it was concluded that the conditions of learning which promote epistemological maturity should be systematically integrated into the required computer course to promote higher level thinking and third-wave applications of computers.

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USING COGNITIVE AND AFFECTIVE MEASURES

by

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This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

Instructional computing is at a crossroads, searching for the appropriate place for the computer in the classroom. In one classroom, the computer is the object of instruction or a supplement to traditional instruction (second-wave). In another, the computer is an integrated part of the content area and a means to teach information processing and reflective judgment (third-wave). Research suggested that the choice of one approach over the other is related to the following factors: teachers' anxiety about technology and teachers' epistemological view of information processing and learning.

The problem of this study was to determine the degree to which prospective teachers' second- or third-wave achievement on a computer-based lesson planning task could be predicted from knowledge of the following set of variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. Level of epistemological maturity was based on a measure of the Perry Scheme of Cognitive development; level of computer anxiety was assessed using a computer attitude scale. Achievement was assessed on a computer-based lesson planning task designed by the researcher and the course instructor to measure both the type and the degree of integration of computer applications into prospective teachers' instructional planning. Participants in the study were prospective teachers enrolled in Montana State University's required teacher preparation computer course during Autumn quarter 1987 or Winter quarter 1988.

Regression analyses indicated that epistemological maturity and age were significant predictors of second- or third-wave achievement. Approximately 35% of the variance in achievement could be accounted for by level of epistemological maturity. Level of computer anxiety was not significantly correlated with achievement.

Based on the analyses, the following conclusions and recommendations were drawn. In the affective domain, it was suggested that less time should be spent in pre-service education addressing issues of computer anxiety and more time should be spent promoting epistemological maturity. In the epistemological domain, it was concluded that the conditions of learning which promote epistemological maturity should be systematically integrated into the required computer course to promote higher level thinking and third-wave applications of computers.

CHAPTER 1

INTRODUCTION

It appears that the field of instructional computing, especially in the area of teacher preparation, has reached a crossroads (Maddux & Cummings, 1986; Siegel & Davis, 1986). The profession is faced with the following dilemma: to resolve not if the computer should be used in instruction but rather how it should be used (Loyd & Gressard, 1984). Several factors over the last twenty years have contributed to the evolution of the dilemma. Each, in its own way, has contributed to the arguments surrounding the appropriate ways to integrate instructional technology into the classroom. The following three factors provide a basis for understanding the complexity of the situation: the epistemological implications of the information explosion, the affective consequences of interacting with technology in the Information Age, and the ways in which teachers have been prepared to deal with these facets of the Information Age.

Over ten years ago the Carnegie Foundation reported that education was entering into a phase dominated by technology (Carnegie, 1972). This phase, the so-called fourth revolution, has been referred to both in

intellectual circles as well as in the popular press as the Information Age or Information Society. In order to understand the educational implications of the Information Age, it is necessary to examine its scope, its effects on society, and its components.

The scope of the Information Age is three-fold. First, it extends and shapes the traditional processes of production and consumption. In other words, the Information Age does not "replace, it overlaps, the growing, extracting, processing, manufacturing, recycling, distribution, and consumption of tangible things" (Cleveland, 1985). Second, the Information Age has been characterized by what has been referred to as an information explosion. Jarvis (1985, p. 5) reported the following estimates for the next decade:

30 billion original documents are created each year, with 630 billion pages of print going through the postal system and 100 billion pages coming off photocopiers. For each employed person, this is enough paper to fill four filing cabinets, containing twelve miles of paper. These figures will probably double in five years.

Third, the Information Age has forced educators to deal with the epistemological implications of the information explosion. Students can no longer be held responsible for assimilating the body of knowledge in a particular discipline. The information explosion precludes that capability. The Information Age requires

that the concept of information processing be redefined. Rather than being defined as a body of knowledge, information must be defined in terms of a continuum. The continuum has as its end points data and wisdom; information falls at approximately the midpoint. The points can be defined as follows (Hartoonian, 1984; Cleveland 1985):

data: undigested observations, uninterpreted facts;
information: data which has been organized by someone other than oneself;
knowledge: organized information which has been internalized by self and integrated into other knowledge;
wisdom: integrated knowledge made useful by theory.

Defining information in this manner implies that learning consists of at least two processes: evaluating the ways information has been organized or interpreted by others and reorganizing information into knowledge. In fact, it has been suggested that one of the major problems facing society is what has been described as a "technological dialectic": technology, in making information more easily accessible, has put the onus of interpretation and verification on the learner -- a burden which requires a high level of critical/creative thinking (Broudy, 1986, p. 235). In addition to these processes, optimum use should be made of the information resource which entails the "interdisciplinary, interdepartmental,

interpersonal, interdependent, and international" exchange of information (Cleveland, 1985, p. 197).

The social implications of the Information Age are equally complex. Harlan Cleveland has suggested that the availability and the power of information would alter the hierarchies of society which have been based primarily on the notion of scarce resources. These hierarchies included the following (Cleveland, 1985, p. 16):

1. hierarchies of power based on control (of new weapons, of energy sources, of trade routes, of markets, and especially of knowledge);
2. hierarchies of influence based on secrecy;
3. hierarchies of class based on ownership;
4. hierarchies of privilege based on early access to valuable resources;
5. hierarchies of politics based on geography.

Students today are being educated in a substantially different world than their parents. Information is instant, global, and only loosely controlled. This condition has raised serious ethical questions concerning issues of ownership, privacy, and abuse of technology. A recent study of children attending a summer computer camp found that children operated as if "all information were open and accessible to anyone who wished to view it" (Diem, 1985, p. 319). In addition, it was concluded that the children "had not previously thought through the ramifications of the use and misuses of technology, and of the information spawned by it" (Diem, 1985, p. 320).

Concurrent to the deep pedagogical changes implicit in the Information Age, there is a deep affective reaction to the demands of coping with and adapting to the technological revolution. Sherry Turkle (1984) of MIT conducted an extensive study of people's reactions to and comments about technology: ranging from elementary school children, to video-game players, to eminent computer scientists. She found that computers were frequently the objects of a great deal of anxiety and that that anxiety was manifested in the ways people personified computers and referred to them as if they were alive.

The most illustrative response came from the children. When quizzed about their computerized toy, Merlin, they responded that Merlin was "sort of alive." When pressed, they commented that Merlin's aliveness was a consequence of the fact that he "cheated" (result of alternative strategies programmed into the toy which won't allow a child to always begin a tic-tac-toe game by placing his/her mark in the middle square). His "unaliveness" was attributed to the fact that, in the children's words, he really didn't care that he cheated (Turkle, 1984).

The educational implications of unprecedented interactions with technology has been the onset of a new malaise: computerphobia (Jay, 1981). Loyd and Gressard

(1984) corroborated other research which has indicated that one of the major factors stymying the infusion of computers into education has been teacher anxiety. Students, growing up in a technological environment, often knew more than their teachers about computers and were also less anxious about using computers in their learning (Anatasio, 1972; Kritek, 1976; Cooper, 1978; Stevens, 1980; Rohner & Simonson, 1981).

Preparing teachers to deal with the knowledge explosion and the concomitant affective response to that explosion has focused, to a large extent, on making teachers aware of and comfortable with the presence of the microcomputer in the classroom (Lesgold, 1986). In the educational arena, technology has generally been in the form of the microcomputer (White, 1983). The pervasiveness of the microcomputer in education was reported in a 1985 survey of 2,300 public and private schools in the United States (Valdez, 1986, p. 5):

There are one million computers in American elementary and secondary schools. Most elementary schools have five or more computers, and half of all high schools have 15 or more computers. One-fourth of the nation's school teachers -- over 500 thousand -- are using computers. The number of computers in schools has quadrupled in the last two years. The best projections are that there will be 3 million computers in elementary and secondary schools by 1990 -- even given the national decline in the purchase of personal computers.

To a lesser degree, preparation of teachers has focused on teachers' philosophical approaches to technology. It is becoming increasingly evident that the presence of a computer did not guarantee that students would learn the appropriate uses or capabilities of technology (Foell, 1983; Fetler, 1985; Walker, 1986). Rather, teachers' philosophical approaches to technology dictated the ways computers would be integrated into the classroom (Davies & Shane, 1986). This problem has generated a dilemma: advances in technology continue to occur while educators struggle with an adequate definition of "computer literacy." The evolution of this dilemma involves the examination of how technology has developed as well as how education has tried to define what is essential knowledge about and experience with technology.

The development of technology has occurred in three stages: the TV stage, the computer stage, and the electronic environment stage (White, 1983, p. 51). Currently, schools tend to be in the computer stage, concentrating on the computer as the object of instruction. However, the rest of society is moving into the electronic environment stage which is characterized by such activities as electronic banking, shopping, and data processing (Fetler, 1985). In addition to these activities, there has been an increase in what has been

termed "telematics": the combination of computers and other forms of electronic communication (Knapper, 1982). Accessing national and international databases and electronic bulletin boards has become part and parcel of today's business world (Cleveland, 1985).

Education finds itself at a crossroads in the search for the appropriate place for the computer in the classroom (Maddux & Cummings, 1986; Siegel & Davis, 1986). Siegel and Davis (1986) have characterized this crossroads as second and third-wave computing. Each philosophical approach defines the appropriate use for computers in the classroom.

Second-wave computing is grounded in nineteenth-century epistemology which characterized information processing as collecting "discrete bits of information (facts) in a manner that leads to objective conclusions (truth)" (Bowers, 1988, p. 44). Pedagogically, second-wave computing involves teaching about the computer in the sense that the computer is the object of instruction and that the power of the computer to process information determines the kinds of applications. Programming, rote drill and practice exercises, and other applications based on binary logic (right/wrong) are commonly found in the second-wave classroom. Primarily, pedagogical questions concerning

the integration of computers into the classroom center on ways in which the computer can enhance traditional instruction and curricula (Siegel & Davis, 1986).

On the other hand, third-wave computing is characterized quite differently. Epistemologically, information processing takes on the characteristics of reflection and evaluation (Bowers, 1988). Computers are less likely to be the subject of instruction and more likely to be a tool of instruction (Watts, 1981). Focus on the computer itself is minimized. Of concern is what is referred to as "computer imagination": the ways in which the computer can be used to "exploit the medium in order to enhance the message" (Siegel & Davis, 1986, p. 91). Engaging in computer imagination requires an understanding of the capabilities and limitations of computer technology but does not require that the computer itself be the object of instruction. Rather, pedagogical concern is with the ways in which the computer impacts the nature of instructional tasks, an exploration of the ways in which the computer may change the nature of classroom activities and interactions and ways in which those differences can be maximized to do things in ways that have never been done before in traditional instruction.

The educational implications of these two approaches to instructional computing impact the ways teachers are

prepared to integrate technology into education. On the bases of those approaches, educators have defined what behaviors and experiences constitute a "computer literate" person. The second-wave focuses almost entirely on reading and writing computer programs, using computer documentation, using computer terminology, and using computers in traditional learning tasks (Taylor et al, 1980; Bitter & Camuse, 1984; Alessi & Trollip, 1985; Siegel & Davis, 1986).

The third-wave has deemphasized programming competencies and has suggested that teachers and students be facile in the following kinds of competencies (Bruwelheide, 1982; Rawitsch, 1982; Anderson, 1983; Adams, 1985; Hawkins & Sheingold, 1986; Maddux & Cummings, 1986; Siegel & Davis, 1986): integration of the computer into subject areas; identification, use and evaluation of applications of computer technology; application of problem solving/decision making aspects of computers and appreciation of the social, moral and global implications of technology. In light of those competencies, Lesgold suggested the following definition of computer literacy (1986, p. 8):

In a sense, "computer literacy" has little if anything to do with handling computers. It is, rather, a set of broad cognitive capabilities that allow one to think deeply, creatively, and efficiently and to communicate the results of that thinking.

One challenge facing education in the Information Age involves preparing teachers "to cope with the gap between technological progress and the human capacity for change" (Knapper, 1982, p. 84). In order to meet this challenge, teachers must adapt to the technological world (Walker, 1985) and identify outcomes and methods more compatible with the Information Age. Teaching may take on the form suggested by Cleveland (1985), Diem (1985) and Shane (1982) which involved the following:

1. "integrative brainwork" -- the ability to efficiently and effectively solve problems, make decisions, and critically evaluate information;
2. focus on social goals, public purposes, costs and benefits of openness;
3. self-analysis and metacognition;
4. practice in "real world" negotiation;
5. integration of global perspectives with issues of personal responsibility;
6. focus on social and citizenship skills which emphasize the use and abuse of information systems;
7. development of ethical standards for information creation and utilization.

Whatever form education will eventually take is beyond the scope of this study. Nevertheless, any change or need will occur within the context of the Information Age. The scope, societal effects, attributes of information, and development of technology will all shape the architecture of education and the demands made on those who deliver instruction.

Statement of the Problem

The problem of this study was to determine if second- or third-wave achievement in a computer-based lesson planning task in a required teacher preparation computer course at Montana State University could be predicted from knowledge of the following set of variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. The attribute variables of interest included age, gender, class standing, level of preparation, and level of prior computer experience.

Need for the Study

The justification for this study has been derived both from the research on the approaches to instructional computing as well as from the results and recommendations of previous research in the fields of epistemological maturity and computer anxiety.

First, researchers, in their discussions of second- and third-wave computing, have contended that the two attitudes which underlie the two approaches were reflective of alternative philosophies of education which were generally unreconcilable (Siegel & Davis, 1986; Walker, 1986). However, Broudy (1986) contended that one's attitude toward instructional computing was a function of his/her perception of and reaction to a

technological world: an epistemological response to the Information Age.

Therefore, the research focusing on the ways in which teachers' levels of epistemological maturity and computer anxiety affected the ways in which they approached learning and their students was examined. As will be discussed, the concept of epistemological maturity provides insight into the ways in which teachers perceive technology and information processing; the concept of computer anxiety will elucidate the ways in which teachers react affectively to technology.

In the area of epistemological maturity several studies discussed the relationship between teachers' epistemological maturity and their approaches to teaching. Beers and Bloomingdale (1983) examined the relationship between the epistemological maturity of twenty teachers at a small liberal arts college and their perceptions of student difficulties. Generally, these teachers attributed student difficulty to effort, personality characteristics, talent, study skills, and concreteness. Those teachers who were assessed as Dualists on the Perry Scheme of Cognitive Development attributed student difficulties to personality characteristics and talent. In other words, the more rigid a teacher was in his/her thought, the more apt he/she was to attribute a student's

difficulty to stable, inherent characteristics which were less amenable to remediation.

Hunt and Germain (1969) observed that teachers who demonstrated more relativistic thought patterns asked twice as many convergent, evaluative, and divergent questions. They were also more supportive of students' learning. Recommendations of this study included a strong argument for the integration of critical thinking skills development in teacher preparation programs.

Research on the relationship between epistemological maturity and critical thinking skill development has also been suggested on the grounds that some of the essential questions concerning the integration of critical thinking into the curriculum were epistemological (Facione, 1984). In addition, it has been suggested that cognitive research include studies of how teachers think (Cuban, 1984).

Examinations of how teachers think must include consideration of the level at which they think and the level of their epistemological maturity. Perry (1970) discussed at length the concept that critical thinking skill was mitigated by the level of epistemological maturity. That is, a Dualist thinker interpreted critical thinking as getting the Right answer. The Multiplistic thinker interpreted critical thinking as including as many points of view as possible with the hope that the Truth

would be included. The Relativist thinker demonstrated behaviors which were considered demonstrative of critical thinking: analysis and evaluation of information. Truth was a matter of personal commitment and judgment. Perceptions of self, others and knowledge affected the way problem-solving or inquiry was approached.

Another factor teacher preparation programs must take under consideration are teachers' level of computer anxiety. A Rand Corporation Task Force emphasized the relationship between attitudinal variables and teachers' successful use of computers across the content areas (Shavelson, et al, 1984). In a general sense, teacher anxiety has been correlated to a number of dysfunctional teacher behaviors such as low rapport with students, less verbal support of student learning, more hostile behavior towards students, increased dogmatism, increased pupil anxiety, increased avoidance of risk, and increased feelings of inferiority, uselessness, loneliness, and betrayal (Keavney & Sinclair, 1978; Youngs, 1978).

More specifically, a number of studies over the last two decades have indicated that children were eager to experience what a computer had to offer, but their teachers resisted integration of the computer into education (Anatasio, 1972; Kritek, 1976; Cooper, 1978; Jay, 1981). Rohner and Simonson suggested that "computer

anxiety among teachers was one factor that was inhibiting the potential benefits of computer technology in education" (1981, p. 551).

More recently, teachers tended to recognize the need for computer skills and methods of integration across the content areas. However, teachers still frequently exhibited anxiety about using computers in their classrooms (Woodrow, 1987). Even after being involved in a five-year implementation plan, teachers resisted integrating computers into instruction and tended toward second-wave perceptions of computers as "a non-threatening addition to tried and true approaches to instruction" (Woodward & Mathinos, 1987, p. 7).

The study provided an opportunity to examine the relationship between the epistemological maturity and computer anxiety of prospective teachers and their subsequent performance on a computer-based instructional planning task. The task was based on the objectives and competencies identified in the instructional computing literature and was designed to determine both the degree and type of integration of computer software into the content areas.

General Questions to be Answered

In order to determine whether second- or third-wave achievement in a computer-based lesson planning task in a required teacher preparation computer course at Montana State University could be predicted from knowledge of the following set of variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables, the following general questions were addressed. These questions fell into two general categories: those dealing with the interrelationships among the predictor variables of interest and those dealing with the prediction of the criterion variable of achievement. The questions were as follows:

1. Are there significant differences in mean levels of computer anxiety with respect to gender and levels of prior computer experience?
2. Are there significant differences in mean levels of epistemological maturity with respect to gender and age?
3. Is there a significant R-Square between the set of predictor variables and the criterion variable of achievement?
4. What are the contributions of the predictor and attribute variables to the criterion variable of achievement?
5. What significant increments to R-Square are associated with the inclusion of the independent variables of level of epistemological maturity, level of computer anxiety, level of prior computer experience, level of preparation, gender, age, and class standing?

General Procedures

Solution to the problem involved several procedures. These procedures included the following: appropriate identification of a population and subsequent sampling, a systematic method for measuring the predictor variables, a systematic method for obtaining appropriate attribute variable information, and a controlled exposure to a computer-based lesson planning task and subsequent measurement of achievement. An overview of these procedures follows.

Population and Sampling

The population for the study included all Montana State University students who met the following criterion: prospective teachers coded in one teacher preparation or teacher certification curricula during Autumn quarter 1987 and Winter quarter 1988. Teacher preparation curricula included the following general categories: elementary education, secondary education, K-12 education, teaching options of curriculum other than education, and teacher certification. Prospective teachers coded in the first four curricula listed were classified as undergraduate students; the last, teacher certification candidates, were classified as graduate students.

The sample for this study consisted of those prospective teachers who met the specified population criterion and who were enrolled in EDIM 251, Foundations of Instructional Computing, either Autumn quarter 1987 or Winter quarter 1988. The number of prospective teachers who met the criterion during Autumn quarter 1987 was 100; the number of prospective teachers who met the criterion during Winter quarter 1988 was 112. The total combined sample of 212 prospective teachers was used.

Preparation for Assessment

Preparation for Assessment involved: training raters, and establishing inter-rater reliability coefficients. These procedures were conducted following Winter quarter of 1988.

Training of reliable raters entailed training raters for the following tasks: rating the Measurement of Epistemological Reflection (Baxter-Magolda & Porterfield, 1985) and holistic rating of achievement on the computer-based lesson planning task.

Rating of the Measurement of Epistemological Reflection was done by the researcher. During the course of the study, the researcher completed the training program developed by the authors of the instrument and certified as a rater with an inter-rater correlation coefficient of .87.

Establishing inter-rater reliability for the computer-based lesson planning task was completed by the researcher and designated EDIM 251 instructor following Winter quarter 1988. A random sample of ten lesson planning tasks was drawn from the course projects and normed.

Measurement of Predictor Variables

Measuring the predictor variables of epistemological maturity and computer anxiety involved the following instruments. Epistemological maturity was measured with the Measurement of Epistemological Reflection (Baxter-Magolda & Porterfield, 1985). Computer anxiety was measured with the Computer Attitude Scale (Loyd & Gressard, 1984).

Measurement of Attribute Variables

Obtaining information on the attribute variables of gender, age, class standing, and prior computer experience involved the following procedures. Prospective teachers self-reported their gender, age, and prior computer experience. Class standing and level of preparation were determined from official class rolls.

Treatment and Measurement of Achievement

As part of the requirements for EDIM 251, prospective teachers completed a computer-based lesson planning task. The lesson planning component of the task entailed standard instruction procedures (Davis, 1979): identification of objectives, evaluation of resources, description of methodologies, description of management strategies, and identification of lesson evaluation procedures. The computer component of the task entailed the degree and type of integration of computer software into the content areas as evidenced in the lesson plan task. Measurement of achievement on that task was based on holistic scoring of the final product of the task.

Limitations

There were several limitations to the study. These were as follows:

1. The sample for this study was not drawn randomly but was drawn from intact groups of prospective teachers who enrolled in the teacher preparation curriculum at Montana State University, Bozeman, Montana, as well as in EDIM 251 during either Autumn quarter 1987 or Winter quarter 1988;
2. Although lesson planning involved both process and product, achievement was determined solely on the basis of the product;
3. Choice of software was limited to that which was available in the Instructional Computing Lab of the Montana State University College of Education;

4. Since the literature was not in agreement concerning the definitions of predictor variables of interest, the choice of definition and subsequent mode of measurement limited the study (Beyer, 1985; Fetler, 1985).

Definition of Terms

The following terms were defined as follows for the study.

Achievement: the degree and type of integration of computer software into the content areas as evidenced in a computer-based lesson planning task. Tasks were rated on a four-point holistic rating scale.

Computer anxiety: "resistance to thinking about computer technology, fear of computers, and hostile or aggressive thoughts about computers" (Loyd & Gressard, 1984).

Computer-based lesson planning: integration of computer software into the content areas using the syntax of instructional planning.

Computer software: computer courseware used for direct instruction such as drill and practice, tutorials, and simulations (Taylor, 1980).

Computer imagination: "the degree to which a lesson exploits the strengths of the computer medium to enhance instruction, rather than merely imitating other teaching media" (Siegel & Davis, 1986, p. 91-92).

Critical thinking: "reasonable, reflective thinking that is focused on deciding what to believe or do." It involves both dispositions and abilities (Ennis, 1962).

Data: undigested observations, uninterpreted facts (Cleveland, 1985).

Dualism or Duality: "a bifurcated structuring of the world between Good and Bad, Right and Wrong and Others" (Perry, 1970).

Epistemological maturity: growth or progression from one structure to a higher structure as defined on the Perry Scale of Cognitive Development (Perry, 1970).

Information: data which has been organized by someone other than oneself (Cleveland, 1985).

Instructional planning: The systematic process of analyzing subject matter, selecting materials and methods, developing and managing delivery, and evaluating outcomes (Davis, 1979).

Knowledge: organized information which has been internalized by self and integrated into other knowledge (Cleveland, 1985).

Level of epistemological maturity: position on the Perry Scale of Cognitive Development which represents "the mode, or central tendency, among the forms through which an individual construes the world of knowledge and values at a given time in his life" (Perry, 1970). Positions ranged from one to five.

Level of computer anxiety: "resistance to thinking about computer technology, fear of computers, and hostile or aggressive thoughts about computers" (Loyd & Gressard, 1984).

Level of preparation: focus of prospective teacher preparation; categories of preparation included: elementary, secondary, and K-12 preparation.

Level of prior computer experience: number of weeks, months or years of computer experience prior to enrollment in EDIM 251. Type of experience was not a consideration.

Multiplicity: "a plurality of 'answers', points of view, or evaluations, with reference to similar topics or problems. The plurality is perceived as an aggregate of discretes without internal structure or external relation, in the sense, 'Anyone has a right to his own opinion' with the implication that no judgments among opinions can be made" (Perry, 1970).

Relativism: "a plurality of points of view, interpretations, frames of reference, value systems and

contingencies in which the structural properties of contexts and forms allow various sorts of analysis, comparison and evaluation in Multiplicity" (Perry, 1970).

Wisdom: integrated knowledge made useful by theory (Cleveland, 1985).

CHAPTER 2

REVIEW OF LITERATURE

In order to put the problem of this study in perspective and to determine its position in the current body of knowledge, it is necessary to examine the research salient to the variables of interest. The chapter is organized in the following manner: each section reviews research pertaining to the variables of interest; research focusing on the background, definition, expansion, validation, and assessment of the variables of interest is presented. Where applicable, research related to possible intercorrelations among variables of interest is discussed.

Epistemological MaturityPerry Scheme of Cognitive Development - Overview

During a ten-year period between 1958 and 1968, William G. Perry and his associates at Harvard University's Bureau of Study Council hypothesized and validated a scheme of cognitive development. The scheme was based on the following assumptions: 1) that cognitive development entailed linear stages characterized by specific phenomenological perceptions; 2) that cognitive

development continued into the adult years; 3) that cognitive development was integrated with moral and ethical development; and 4) that students confronted the pluralism of academia in systematic ways (Perry, 1968, 1970).

The first assumption was grounded in what Perry referred to as "developmental phenomenology" (1970, p. 106). This philosophical stance provided an explanation for two basic components of the scheme. First, it addressed the notion that as maturation occurred, discernible stages could be identified. Second, it reinforced previous cognitive research which suggested that perceptions of reality and learning evolved over time and that each stage was characterized by specific ways of looking at self, others and knowledge (Piaget, 1950).

The second assumption was based on Perry's belief that stages of cognitive development did not end in adolescence with formal operational thought as suggested by Piaget (1950). Rather, he proposed that adults matured through nine additional stages, or positions. However, Perry did not reject Piaget's underlying constructs. He maintained that the processes of assimilation, accommodation, and equilibrium/disequilibrium explained the ways in which cognitive maturation occurred (Perry, 1970). Subsequent research confirmed that cognitive

maturation occurred concurrently with cognitive thought development (Porterfield, 1984; Perry, B., et al, 1986). In relation to teacher preparation, Sprinthall and Thies-Sprinthall (1983) discussed the implications of ongoing cognitive maturation in relation to viewing teachers as adult learners.

The third assumption evolved from what Perry perceived to be a lack of integration between the research conducted in the realms of moral/ethical development (Kohlberg, 1964) and cognitive development. Assuming perceptions of reality and knowledge were mitigated by cognitive development, it was logical that moral/ethical beliefs and actions were also related to epistemological maturity (Perry, 1970).

The final assumption provided the basis for a three-phase study which developed and validated the scheme. Each phase was characterized by a unique purpose and methodology (Perry, 1968). A brief examination of each phase will illustrate the process by which the Perry Scheme of Cognitive Development emerged.

Phases of the Study

Phase One was focused on describing what Perry and his colleagues surmised to be systematic patterns of development. Through their advising and counseling contacts with students, they found that students tended to

respond to the pluralism of higher education in particular ways. The students verbalized certain perceptions of self, others and knowledge which changed over the course of their education. These perceptions suggested the possibility of stages (Perry, 1968, 1970).

The following methodology was utilized to factor out and describe student perceptions in terms of stages of cognitive development: the Checklist of Educational Views (CLEV), an instrument designed to place students on a continuum ranging from dualistic to relativistic thought, was administered to a random sample of college freshmen in the fall and spring of 1958 (Perry, 1968).

In order to validate the continuum, phase two was initiated which involved recorded interviews with students. A sample was drawn from the following strata of the original group: students with extreme dualist scores, students with extreme relativist scores, students with mean scores, and students who showed the most change in fall and spring scores. These students were invited for interviews. Results of the CLEV and the subsequent interviews allowed Perry to sketch out nine stages of development, one condition of delay, and two conditions of alienation. The resulting Chart of Development and Glossary of Terms were the basis for the final phase of validation (Perry, 1968).

The last phase of the process involved rating student interviews on the basis of the Chart of Development. A new random sample of students was drawn. These students were invited for interviews which resulted in 67 complete four-year reports. In order to verify the underlying stages of development, six lay raters were asked to rate the following: four-year protocols, single interviews, excerpts, and condensed four-year reports. Inter-rater reliability was calculated for each rating task. High correlations supported Perry's assertion that raters had identified underlying stages of development (Perry, 1968).

Chart of Development

The Perry Scheme of Cognitive Development incorporated nine positions, one condition of delay, and two conditions of alienation. Each position described the ways in which self, others and knowledge were perceived in the process of making sense of the world (Perry, 1968, 1970). A condensed overview of the nine positions illustrates the phenomenology of development.

Dualism. Positions 1, 2, and 3 were predicated on the assumption of a bifurcated world. Self was seen in opposition to others, especially those in power who knew the Truth. Knowledge was based on right vs wrong, or good vs bad. Getting an education entailed working hard,

doing what "they" said, and finding the right answers to questions (Perry, 1970).

Multiplicity. Positions 4 and 5 were predicated on the assumption of a pluralistic world. Self was seen as one of many having an opinion about an issue. While there were no absolutes, Authority - those in power - still knew the best Truth. Knowledge was based on pluralism but not on critical judgments about the worth of one stance over another. Getting an education entailed having the right to one's own opinion but also being subjected to evaluation by an external Authority (Perry, 1970, 1981).

Relativism. Positions 6, 7, 8 and 9 were predicated on the assumption of a pluralistic world and on the necessity of individual commitments. Self was seen as a decision-maker whose power rested in the ability to arrive at solutions after the examination of alternatives. Authority lost its status as the knower of Truth because the power of knowing shifted to the learner. Knowledge was mitigated by a dimension of commitment. Getting an education entailed individual investigation and acceptance of the relative nature of knowledge (Perry, 1970, 1981).

In addition to the nine positions, conditions which interrupted development were postulated. Temporizing involved a condition of delay in which growth was suspended for approximately a year and a holding pattern

was maintained. Escape involved two conditions of alienation: Dissociation which involved choosing to remain in a multiplistic mode in order to avoid taking responsibility and Escapsulation which involved tolerance of multiplicity in others as long as it did not impact dualism of self (Perry, 1970, 1981).

Limitations of the Perry Scheme

Perry and subsequent researchers have indicated that the original study which gave rise to the Chart of Development was limited in several respects. Perry listed the following: use of student volunteers and the possibility of interviewer influence (1968, p. 5). In addition, the restricted nature of the population may have accounted for the discrepancies between Perry's findings and more recent research. The population, freshmen attending Harvard between 1958 and 1963, may not have been representative of college freshmen in general. Students were generally of traditional age, all male, and subject to competitive entrance requirements (Perry, 1968).

Results of Perry's study indicated that a majority of college freshmen were identified as being in positions 3-5. In other words, the freshmen year was characterized by dualistic and multiplistic views. On the other hand, 75% of the seniors were placed in positions 6-8 which reflected relativistic thought (Perry, 1968, p. 15).

Subsequent research on college students in a large public university placed freshmen and sophomores at the 2-3 level, seniors at the 3-5 level, first year graduate students at the 3-5 level, and advanced graduate students at the 6-7 level (Knefelkamp & Slepitzka, 1976, p. 52).

Additional research has also been recommended in the following areas: expansion and elaboration of the scheme, utilization of the scheme in instructional and curricular design, and development of instruments to assess stages of development (Perry, 1981, p. 98).

Expansion and Elaboration of the Scheme

Expansion and elaboration of the Perry Scheme has focused on clarification of the linear, vertical nature of the scheme and on correlations with other areas of human development. Perry, himself, dealt with the linearity issue. In his original work, he suggested the possibility of what he called horizontal decalage, the process through which "individuals mature in different areas of their lives" (Perry, 1968, p. 89). That is, lateral growth should not be confused with temporizing, a period of no growth. Later, he suggested that development not be seen as a strict, lockstep progression but as a "helix of development" with each stage spiralling up from another with a new twist (Perry, 1977, p. 51).

In their work with Ohio State college students in a career development course, Knepfelkamp and Slepitzka elaborated on the concept of lateral growth. The relationships among the behaviors associated with decision-making and levels of cognitive development were examined. Behaviors considered were as follows: locus of control, analysis of information, synthesis of information, modes of expression, self-processing skills, openness to alternative perspectives, ability to assume responsibility, ability to take on new roles, and ability to take risks with self (1976, p. 54). Evidence indicated that the level of epistemological maturity was related to the behaviors. For example, dualists tended to see career choice as motivated by external pressures and culminated with the one "right" career, while relativists viewed the choice as a personal one among alternatives (1976, p. 57).

Additional research which related level of epistemological maturity to the problem solving process characterized the process in terms of cycles through the entire spectrum of the scheme. In the absence of information, a problem was viewed dualistically, as having a "right" answer. In the presence of limited information, a problem was viewed in multiplistic terms, as having many possible and equally plausible solutions. In the presence of extensive information and critical judgment, a problem

was viewed relativistically, as having a defensible solution. Cognitive development "cycles across different areas or situations and . . . the nature of the cycling changes with experience" (Sheese & Radovanic, 1984, p. 16).

Expansion of the Perry Scheme has also been in terms of correlations with other aspects of human development. Heffernan focused his research on the upper positions of the scheme in order to examine the relationship between "forms of thought and styles of establishing values and personal identity" (1975, p. 493). The correlation between establishing identity through commitments was supported (Heffernan, 1975).

Utilization in Instructional and Curricular Design

Research into ways the Perry Scheme might be utilized in designing instruction and curriculum has focused on two aspects of instruction: intervention and environment.

Several studies have examined the effects of "developmental instruction", a method of instruction characterized by direct attempts to facilitate cognitive development (Knefelkamp, 1974; Widick, 1977). Widick hypothesized that academic performance and satisfaction in a college literature course would be higher when instructional components matched a student's level of epistemological maturity than when components and status

were mismatched. Two teaching approaches were designed and implemented in two sections of the course. Inferential findings were not significant. Differential performance and satisfaction could not be attributed to teaching approaches. However, descriptive findings supported previous research which indicated that students at different levels of epistemological maturity approached learning in qualitatively different ways (Widick, 1977).

In a similar study, Knepfelkamp hypothesized that instruction could be designed in such a way as to facilitate growth in epistemological maturity. Utilizing a design similar to Widick, she utilized two methods of instruction in two sections of a college course. One method was designed to facilitate movement of dualistic thinkers to relativistic thinkers. The second method was designed to facilitate movement of relativistic thinkers to commitment. Although 28 of the 31 students experienced cognitive growth, it was not conclusive that this was attributable to developmental instruction (Knepfelkamp, 1974).

Another approach to the utilization of the Perry Scheme in instruction focused on the creation of a challenging but supportive environment in which growth could occur. In fact, Perry questioned the professionalism of direct intervention in student growth

and attributed resistance to growth "not as a sign of stubbornness but of integrity" (Perry, 1977, p. 52). He also suggested that the primary educational application of the Scheme would be in determining "what environmental sustenance most supports students in the choice to use their competence to orient themselves through Commitments" (Perry, 1970, p. 213).

Development of an environment which supported cognitive growth was examined in the context of traditional and innovative educational settings. Variables considered included: peer interactions, faculty-student interactions, curriculum structure and course-work, and extra-curricular activities (Heffernan, 1975, p. 502). It was found that the two environments did have differential effects on identity formation and epistemological maturity (Heffernan, 1975).

Assessment of Epistemological Maturity

The assessment of epistemological maturity has evolved from Perry's original method of interviews and written protocols to paper and pencil assessments. This evolution has also attempted to deal with some of the issues associated with different types of measurement.

Several methods of assessment have been patterned after the interview method. One such method required students to select a response from a predetermined set and

to justify or talk about their selection (Clinchy, et al, 1977). A similar assessment required students to paraphrase paragraphs from their own perspectives (Kurfiss, 1977). Taylor, in the discussion of the assessment instrument, remarked that these methods "rested on the assumption that respondents would be able to accurately discuss statements or paragraphs representative of their developmental level" (Taylor, 1983, p. 2).

Development of a paper and pencil assessment originated as an alternative method which would eliminate some of the drawbacks of the interview method. The interview was time consuming, required extensive rater training and was subject to interviewer bias (Erwin, 1983, p. 6).

The Knepelkamp-Widick, KneWi, instrument was one of the first paper and pencil instruments to evolve. It required students to complete five sentence stems and to write two essays which addressed students' thinking on a particular issue. A revised version of this instrument, the Measure of Intellectual Development (MID), was developed and used extensively in research dealing with developmental instruction (Knepelkamp, 1974; Widick, 1977; Taylor, 1983).

In an attempt to streamline assessment further, Erwin developed the Scale of Intellectual Development (SID).

SID assessed students on the following factors: Dualism, Relativism, Commitment, and Empathy (Erwin, 1983, p. 7).

Taylor developed an instrument, the Measure of Epistemological Reflection (MER), which addressed what she considered to be both the drawbacks of the MID and SID as well as of the complexity of assessment. Her critique indicated that the MID did not separate specific content from general epistemological maturity or provide follow-up questions designed to ascertain underlying reasoning patterns. Similarly, SID did not assess reasoning strategies (Taylor, 1983, pp. 1-2)

In addition to the drawbacks of these instruments, Taylor suggested that the complexity of assessment must be addressed. Drawing on the work of Loevinger and Wessler, she indicated that the following must be considered in assessment: "all kinds of development occur simultaneously, making separation of strands of development difficult . . . subjects exhibit behaviors representative of more than one developmental level . . . signs that appear in earlier stages reappear later in more complex forms and . . . all these factors lead to error in matching behavioral signs to underlying development" (Taylor, 1983, p. 2).

Based on these considerations of complexity, several criteria were suggested for evaluation of an assessment

instrument. These included: specific descriptions which distinguished intellectual development from other types of development; structured stimuli which elicited information about intellectual development without interference of content; and a comprehensive rating manual (Taylor, 1983, Taylor & Porterfield, 1984).

The Measure of Epistemological Reflection (MER) was based on these criteria and considerations. It measured epistemological maturity in six domains: decision making, role of peers in learning process, role of the learner, role of the instructor, evaluation, and the nature of knowledge (Taylor & Porterfield, 1984, p. 2). These domains were assessed by means of a general reference question which was followed by a series of follow-up probes designed to gather data about reasoning processes. The manual included general description of each position, examples of reasoning structures associated with that position, and example protocols. Reliability was established through inter-rater reliability procedures. Validity was established concurrently with the MID (Taylor, 1983; Taylor & Porterfield, 1984; Baxter-Magolda & Porterfield, 1985).

Epistemological Maturity and Age:

Perry noted in his study with Harvard students that as students matured, they tended to move into the higher levels of epistemological development. Freshmen were primarily found to be in the Dualistic stages, while seniors were found to have developed into the Multiplistic and Relativistic stages (Perry, 1970). Based on this apparent development, it could be assumed that level of epistemological maturity was directly correlated with chronological age.

However, additional research demonstrated that epistemological maturation does not always follow a predictable, linear pattern. Cameron (1984), in her work with adult learners, investigated the epistemological maturity of 46 nontraditional-aged college students. The mean age of these students was 41 years; the age range was 22 to 48. Through a protocol and interview method, Cameron ascertained the epistemological maturity levels of these nontraditional students. Results indicated the following: 63.3% of the sample were at the Dualistic stage; 26% were at the Multiplistic stage; and 10.8% were at the Relativistic stage. She concluded that the older, nontraditional student was more likely to be at a lower level of epistemological maturity rather than at a higher stage and that epistemological development was mitigated

by such factors as socialization and exposure to pluralism (Cameron, 1984).

Epistemological Maturity and Gender

One of the limitations to Perry's research cited in subsequent research has been related to the fact that Perry validated the Scheme of Cognitive Development on an exclusively male population (Clinchy, et al, 1977; Clinchy & Zimmerman, 1982; Belenky, et al, 1986; Baxter-Magolda, 1987).

A longitudinal study at Wellesley College was conducted to determine if women followed paths of epistemological development similar to established male patterns. Through the interview method, data were collected from 90 undergraduate women whose epistemological development was tracked through their four years of school. Generally, the researchers discovered that the women tended to conform to the same scheme of development as the males included in Perry's research (Clinchy & Zimmerman, 1982).

In an effort to expand the scope of epistemological maturity from the exclusive, private institution sphere, an extensive study of women's epistemological development was conducted with women not only from a state university environment but from social family agencies as well. Interviews with 135 such women revealed that women's

epistemological development followed a parallel but different pattern. Stages identified in the study were as follows (Belenky, et al, 1986):

Silence: complete submission to authority;
Received Knowledge: reliance on authority;
Subjective Knowledge: reliance on personal intuition;
Procedural Knowledge: reliance on problem solving;
Constructed Knowledge: reliance on contextual criteria.

Closer inspection of these stages revealed a number of similarities with the Perry Scheme. Received knowledge was similar to the Dualistic stage. However, manifest behaviors of male and females in these stages differed. Dualistic men demonstrated a tendency to identify with authority and to lecture others about the rightness of their position. Women tended to be awed by authority and to listen to other's opinions rather than verbalize their own (Belenky, et al, 1986, p. 43).

Subjective knowledge and procedural knowledge stages were similar to the Multiplistic stage. However, as in the previous stage, manifest behaviors differed. When faced with a variety of interpretations, Multiplistic men tended to express that "they had a right to their opinion." Women, on the other hand, were more apologetic and expressed that "it was only their opinion." (Belenky, et al, 1986, p. 66).

The constructed knowledge stage was similar to the Relativistic stage. However, it was noted that women have traditionally not been allowed into the "fraternity of knowing" and have little opportunity in higher education to participate in the community of scholars which characterizes this higher level (Belenky, et al, 1986, p. 194).

The notion that epistemological maturity may be gender related rather than gender specific was investigated in a recent study. The Measure of Epistemological Reflection was administered to 50 undergraduate men and 50 undergraduate women at a state university. Subsequent comparisons revealed that there were no significant differences between the mean level of epistemological maturity of the males and the females (Baxter-Magolda, 1987).

However, separate patterns of responses were discovered when the reasoning structures of the two groups were compared. The women students tended to manifest reasoning patterns in five domains of the instrument as follows: role of the learner = receiving answers from authority; role of peers = support; method of instruction = interaction to reduce pressure on students; evaluation = numerous opportunities to demonstrate competence; and nature of knowledge = differentiation between fact and

opinion with an emphasis on personal interpretation (Baxter-Magolda, 1987).

Males tended to manifest other reasoning patterns in the same five domains. Their responses were as follows: role of learner = searching out answers; role of peers = source of argument; method of instruction = active argumentation and discussion; evaluation = feedback for correction; nature of knowledge = determining degree of detail with an emphasis on research (Baxter-Magolda, 1987).

Therefore, while there were no significant differences between the two groups with regard to mean levels of epistemological maturity, there were descriptive differences between the reasoning structures of the groups. Males were characterized by a more active, critical response to learning; females were characterized by a more supportive, personal response.

Computer Anxiety

Definition

Computer anxiety has been defined a number of ways by various researchers. In order to understand the implications of those definitions, it is first necessary to examine the concept of anxiety itself. Spielberger (1966) suggested that anxiety was a two dimensional

reaction to psychological stress. The first dimension was characterized by a temporary reaction to a stressful environment and was referred to as a state. The second dimension, characterized by a more permanent construct of the personality, was referred to as a trait. Definitions of computer anxiety tended to be grounded in this two-dimensional view of anxiety and to emphasize the state dimension of anxiety.

Powers (in Cambre & Cook, 1985) focused on physiological changes elicited by a state of anxiety. Such changes were in the following systemic functions: "systolic blood pressure, diastolic blood pressure, heart rate and electro dermal responses" (p. 41). Computer anxiety was defined, then, in terms of the physical reactions manifested when a person was anxious.

Other researchers concentrated their attentions on the psychological and affective manifestations of computer anxiety. Raub (in Cambre & Cook, 1985) defined computer anxiety in terms of a continuum which ranged from fear and mistrust of computers to appreciation of computers.

Rohner and Simonson (1981) defined computer anxiety as "the mixture of fear, apprehension, and hope that people feel when planning to interact or when actually interacting with a computer" (p. 551). This definition

also emphasized the state of anxiety elicited by technology.

Maurer and Simonson (1984) defined computer anxiety as "the fear and apprehension felt by an individual when considering the implications of utilizing computer technology, or when actually using computer technology" (p. 321). In this sense, computer anxiety was considered primarily a state which was evoked by either thinking about or interacting with technology.

Loyd and Gressard (1984) defined computer anxiety as "resistance to thinking about computer technology, fear of computers, and hostile or aggressive thoughts about computers" (p. 67). Similarly, the definition reflected the state of anxiety.

Although each of these definitions reflected similar concepts of the state dimension of anxiety, each served a different purpose and could not be used interchangeably. The primary distinction among these definitions was that each served as the operational definition for a specific computer anxiety assessment procedure.

Assessment of Computer Anxiety

The assessment of computer anxiety has taken two forms: physiological measurement techniques and self-report attitude scales. The first type was derived from the work of researchers such as Powers whose goal was

to validate the construct of computer anxiety through observational data. Powers (in Cambre & Cook, 1985) hypothesized that interaction with a computer would elicit specific changes in four major physiological functions. Results indicated that over time physiological reactions were less severe, and it was concluded that computer anxiety was diluted by continuous exposure.

The second type of assessment took the form of a self-report attitude scale. Raub (in Cambre & Cook, 1985) developed the Attitudes Toward Computers Scale which consisted of forty-two items. These solicited responses using a Likert scale to questions dealing with feelings toward computers. Questions focused on how one felt when thinking about a computer and how one felt when interacting with a computer. A high score on the scale indicated that the subject appreciated computers; a low score indicated that the subject feared and mistrusted computers.

Rohner and Simonson (1981) developed a computer anxiety scale, the Computer Anxiety Index, to measure both the construct of computer anxiety as well as to examine possible correlates with computer anxiety. The scale consisted of sixty-three items which dealt with attitudes concerning cognitive responses to computers, affective responses to computers, and behavioral responses to

computers. A high score on the scale indicated high computer anxiety; a low score indicated low computer anxiety. In addition, the researchers correlated anxiety scores with gender, subject area preparation, hemisphericity, and field dependence. Based on these correlations, it was determined that there were no significant correlations between computer anxiety and gender, subject area preparation, or field dependence. There was a significant correlation between computer anxiety and hemisphericity.

Maurer and Simonson (1984) redesigned the Computer Anxiety Index "to measure the trait of computer anxiety and to predict the development of the state of computer anxiety" (p. 320) and to address a major criticism that the original CAIN measured intent to use computers rather than anxiety about computers. In the second version, twenty items were included which were scored on a six point Likert scale of disagreement/agreement. The items were designed to measure the following behaviors: the avoidance of computers, excessive caution with computers, negative remarks about computers, and attempts to cut short the necessary use of computers.

Loyd and Gressard (1984) developed the Computer Attitude Scale (CAS) to measure the following four aspects

of interaction with computers: computer anxiety, computer confidence, computer liking, and computer usefulness.

The scale consisted of forty items which asked subjects a variety of positively and negatively worded statements concerning computers. A total mean score was derived from these forty items; the higher the mean score, the more positive the attitude toward computers in general. Four subscale scores were also derived which indicated the degree to which subjects related to computers on the aforementioned aspects. Higher subscale scores indicated less anxiety, more confidence, more appreciation, and more perception of utility, respectively. In addition, the researchers examined the relationships between scores on the CAS and the factors of age, gender, and previous computer experience.

Computer Anxiety and Gender

The relationship between computer anxiety and gender has been the subject of numerous studies. A review of these is beyond the scope of this study. However, a cursory look at several studies demonstrates that the relationship between gender and computers centered around two basic themes: competency of males and females with computers, and male and female perceptions of the functions of computers in learning.

Research which has assessed competency of males and females has demonstrated that, generally, males outperform females on measures of computer literacy. One such assessment involved a statewide assessment of computer knowledge, attitudes and experiences of both a sample of sixth graders as well as a sample of twelfth graders. At both levels, the boys outperformed the girls on all major areas: understanding computer functions and uses, understanding the impact of computers on everyday life, understanding hardware components, and understanding computer science problem solving (Fetler, 1985).

A more indepth comparison between male and female attitudes toward computers uncovered two factors which, in part, explained the differential performance of males and females on computer tasks. The first factor centered around perceptions of the computer as a male-appropriate tool. A survey of the computer-related attitudes of 1600 elementary and secondary students, reinforced that one reason boys did better on computer tasks was because they perceived computers to be more appropriate for males than females. Females perceived the computer as generally inappropriate for females and demonstrated less interest in learning how to use one (Wilder & Mackie, 1985).

In addition to the perception that computers were more appropriate for males than females, research has

indicated that females perceived computers to be a part of disciplines which were also more appropriate for males than females, namely math and science (Hawkins, 1985; Wilder & Mackie, 1985). In a way, females were twice-removed from computer technology. The computer itself was perceived as being more appropriate for males, and the computer was perceived as being a part of disciplines which were perceived as being more appropriate for males.

A second mitigating factor focused on the functions of the computer. When students were asked more specifically about computer use, several patterns emerged. Males preferred computer applications which involved programming, solving math problems, and using data processing. Females, on the other hand, preferred computer applications which involved graphics and word processing (Hawkins, 1985). These findings have been corroborated, and it has been suggested that females tended to perceive the computer as a means to an end rather than as an end in itself (Schubert, 1986).

Computer-based Instructional Planning Descriptions of Second and Third-wave Computing

In order to design a computer-based lesson planning task, it was necessary to further elucidate the concepts of second-wave and third-wave computing. A cursory

discussion of the underpinning philosophy, role definitions, and teacher competencies for each approach are discussed.

Second-wave Instructional Computing

General Characteristics: the second-wave approach was described as operating on the following principles (Siegel & Davis, 1986; Maddux & Cummings, 1986). First, instructional applications of the computer were based on the perception that the appropriate use of a computer was to maximize its power to make traditional instruction more efficient and effective. Technology was defined in terms of hardware; the metaphor of the classroom was the factory (Foshay, 1980). Attendant to those perceptions was the notion that the communication process could be described as a communication equation: teacher sent, student received, and output was standardized. The utilization of the computer did not depart significantly from actualizing the traditional curriculum. Even the introduction of programming in the classroom was predicated on the notion that it facilitated sequential, logical thinking skills - a notion which has not been borne out by the research (Maddux & Cummings, 1986).

With respect to role-definition in the second-wave approach, it would be fair to say the following descriptions characterize the roles assigned to computers,

learners, and teachers. First, the computer was seen as both an object of instruction (programming) as well as a means to complement instruction (drill & practice). In either case, the application was programmer-centered. And in most cases, the computer was used as a kind of electronic task master, putting students through their paces in drill and practice and rote learning.

Role of Information: the underlying epistemology of second-wave computing was based on the notion that a finite body of knowledge existed which could be searched and sorted to arrive at Truth. Information processing was perceived as manipulating this collection of facts and interpretations by means of binary logic to determine that which was Truth and that which was not Truth (Bowers, 1988).

Role of the learner: the role of the learner in the second-wave approach was two fold: to assume the role of programmer or to respond to the constraints imposed on him or her by another programmer. Recalling the communication formula, the learner was viewed as a relatively passive receiver, one who required minimal interaction with the computer. Therefore, the types of applications of computers were characterized by rote learning and minimal interaction.

Role of the teacher: the role of the teacher in the second-wave approach was built on the premise that he/she was the primary delivery person of information and instruction. For that reason, the teacher tended to separate computer work from the rest of classroom instruction and to utilize the computer for purposes of supplementary drill or for rewards after other work had been completed.

In addition, the teachers assumed the role of programmer. The typical second-wave curriculum for teacher preparation was representative of what a teacher was expected to do in order to utilize computer technology. Bitter and Camuse (1984) and Alessi and Trollip (1984) delineated the following competencies for teachers in preparing lessons in the computer age. Teachers had to be able to . . .

1. define what was to be taught
2. locate resources
3. generate objectives
4. organize (prioritize) objectives
5. sketch out lesson displays (computer screens)
6. flow chart the lesson
7. program the lesson
8. evaluate the quality of the lesson
9. evaluate the effectiveness of the lesson

The first four steps of this planning process were not substantially different from the planning of any lesson. The additional steps of designing, coding, and debugging a computer program reflected the second-wave notion that teachers needed to take the lead (control) in developing computer courseware. This view had been precipitated in part by the lack of good commercial courseware, a problem that has been continually and successfully remedied (Rawitsch, 1982).

Third-wave Instructional Computing

General Characteristics: The third-wave approach was described as operating on the following principles (Siegel & Davis, 1986; Maddux & Cummings, 1986). The appropriate use of computer technology was to maximize "computer imagination" (Siegel & Davis, 1986), the exploration of ways in which the computer could change the nature of the instructional task. Technology was defined in terms of the means of problem solving; the metaphor of the classroom was an organism (Foshay, 1980). Attendant to those perceptions was the notion that the communication process could be described as a flexible interaction: the teacher and student were partners in communication; output was dependent on the relative impact of a number of contingencies which would include such factors as communication barriers (Havelock, 1969), motivation

differentials, and drives toward homeostasis. The ultimate goal was not to standardize the output but to maximize both individuality and connectedness.

With respect to role-definition in the third-wave classroom, the following descriptions characterize the roles assigned to computers, learners and teachers. First, focus on the computer itself was minimized. Of concern were the ways, as Siegel and Davis contended, to "exploit the medium in order to enhance the message" (1986, p. 91). Engaging in computer imagination required an understanding of the capabilities of and limitations to computer technology but did not require that the computer itself be the object of instruction.

Role of Information: the underlying epistemology of third-wave computing was based on the notion that information existed on a continuum which had as its end points data and wisdom. Information processing was perceived a reflective process by which data was transformed into wisdom (Hartoonian, 1984; Cleveland, 1985; Bowers, 1988).

Role of the learner: the role of the learner in the third-wave classroom was much different than in the second-wave classroom. Again, based on the communication model, the learner and the teacher were in partnership to not only share in the body of knowledge but to also share

in the underlying processes of learning. With respect to computer applications, the focus was on the learner not on the computer; and, in fact, the ultimate goal of students' interaction with computers was empowerment (Lesgold, 1986; Wall, 1986; Valdez, 1986) and higher-order critical and creative thinking (Pogrow, 1985).

Role of the teacher: the role of the teacher in the third-wave classroom was again related to the communication model: he/she was a partner in the learning process and thus was less concerned with differential power equations. Examinations of new methods and new applications were the focus of instructional planning. These teachers were less concerned with the distinctions among different applications of instructional computing (Taylor, 1980). Rather, they were more concerned with exploring the ways in which the computer could change the nature of classroom activities and the ways in which those differences could be maximized to do things in new and unique ways. The ultimate goal of the third-wave teacher was to become a truly "mediated teacher" (Finn, 1964; Heinich, 1970). The ultimate goal of instructional planning was to integrate the computer into all aspects of instruction.

Consequently, the types of competencies associated with third-wave computing differed from those associated

with second-wave computing. Therefore, the ability to design and execute a lesson which integrated the computer both into the subject area as well as into the total picture of the technological age required a different set of competencies. Many of these have appeared in the research to date, sometimes in the form of student competencies (Bruwelheide, 1982; Rawitsch, 1982; Anderson, 1983; Uhlig, 1983; Adams, 1985; Hawkins & Sheingold, 1986). It should go without saying that teacher competencies precede student competencies. Teachers would have to be able to . . .

1. operate a computer
2. access the research base of their subject area
3. integrate the computer into their subject area
4. identify, use and evaluate applications of computer technology
 - a. information retrieval systems
 - b. support software
 - c. instructional software
 - d. utility software
5. distinguish between limitations and capabilities of both alternative forms of technology and computer technology
6. compare/contrast alternative forms of technology and computer technology

7. assess their cognitive and emotional responses to technology
8. utilize critical/creative thinking skills
9. utilize problem solving/decision making skills
10. demonstrate high levels of literacy
11. appreciate social, moral and global implications of technology
12. engage in computer imagination

The distinctions between second-wave and third-wave computing provided two different perspectives on the role of information in learning, the role of the computer, the role of the student, and the role of the teacher in the instructional experience. The different set of teacher competencies provided two different perspectives on the method of computer-based instructional planning.

CHAPTER 3

PROCEDURES

The problem of this study was to determine if second- or third-wave achievement on a computer-based lesson planning task in a required teacher preparation computer course at Montana State University could be predicted from knowledge of the following set of prospective teacher variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. The attribute variables of interest included age, gender, class standing, level of preparation, and level of prior computer experience.

The procedures utilized to address this problem are discussed in the following sections:

1. Population Description and Sampling Procedures;
2. Methods of Data Collection;
3. Statistical Hypotheses;
4. Methods of Data Analysis.

Population Description and Sampling Procedures

The population for the study included all Montana State University prospective teachers who met the following criterion: students coded in one of the teacher

preparation or teacher certification curricula during Autumn quarter 1987 (N = 1200) or Winter quarter 1988 (N = 1223). The population for the study consisted of three subgroups of prospective teachers.

The first subgroup consisted of those prospective teachers who during the 1987-88 academic year were coded into one of the teacher preparation options which required EDIM 251, Foundations of Instructional Computing, as a professional course. Those options were as follows: Art Education Broadfield, Art K-12, Agricultural Education Broadfield, Agricultural Education Teaching, Industrial Arts Broadfield, Industrial Arts Teaching, Elementary Education, Home Economics Education, Physical Education K-12 Broadfield, Physical Education K-12 Health, Secondary Education, Biology Teaching, English Teaching, History Teaching, and Modern Language Teaching. These prospective teachers were classified as undergraduate students.

The second subgroup consisted of those prospective teachers who during the 1987-88 academic year were coded into one of the following teacher preparation options which did not require EDIM 251, Foundations of Instructional Computing, as a professional course. Those options were as follows: Music Education K-12, Business Education, Chemistry Teaching, Mathematics Teaching, and

Physics Teaching. These prospective teachers were classified as undergraduate students.

The third subgroup consisted of those prospective teachers who during the 1987-88 academic year were coded into the teacher certification curricula. Those prospective teachers were classified as graduate students.

The sample for this study consisted of those prospective teachers who met the specified population criterion and who were enrolled in EDIM 251, Foundations of Instructional Computing, either Autumn quarter 1987 or Winter quarter 1988. During Autumn quarter 1987, 120 students were enrolled in EDIM 251. The following subjects were excluded from the sample: 13 students dropped the course, 5 students were not coded into one of the teacher preparation or certification programs, and 2 students failed to complete the course. The number of prospective teachers who met the criterion and completed the course was 100.

During Winter quarter 1988, 143 were enrolled in EDIM 251. The following subjects were excluded from the sample: 12 students dropped the course, 18 students were not coded into one of the teacher preparation or certification programs, 1 student chose not to participate in the study, and 1 student did not complete the course. The number of prospective teachers who met the criterion

and completed the course was 112. The total combined sample of 212 prospective teachers was used.

The sample for the study was not chosen at random; rather, it consisted of those prospective teachers who met the population criterion and who had elected to enroll in EDIM 251 during the quarters of interest. Therefore, a profile of the population of prospective teachers at Montana State University was developed from enrollment data supplied by the Registrar's office. The population profile was compared to the sample profile to determine any significant deviations relative to the following variables of interest: gender, class standing, and age. Procedures suitable for determining the representativeness of the sample were used (Ferguson, 1981).

The population and sample were compared on the basis of gender distribution. Using the proportion of males and females in the population, a Chi square goodness of fit test (Ferguson, 1981, p. 206) was employed to determine if the sample deviated significantly from the expected population distribution. The representativeness of the sample with respect to gender was determined using population values derived from enrollment data.

The population and sample were compared on the basis of class standing distribution. Using the proportion of prospective teachers in each class in the population, a

Chi square goodness of fit test was employed to determine if the sample deviated significantly from the expected population distribution.

The population and sample were compared on the basis of mean age. Using the mean age of the prospective teachers in the population, a one-sample t test (Ferguson, 1981) was employed to determine if the sample mean age were significantly different from the population mean age. The "TSingle" program from the MSUSTAT statistical package was utilized to make the necessary calculations.

Methods of Data Collection

The methods of data collection varied with each variable of interest. Therefore, this section is organized in the following manner:

1. assessment of criterion variable: achievement on computer-based lesson planning task;
2. assessment of predictor variables: level of epistemological maturity and level of computer anxiety;
3. assessment of attribute variables: age, gender, class standing, level of preparation, and level of prior computer experience.

Assessment of the Criterion Variable

The dependent variable of achievement was based on performance on a computer-based lesson planning task. This task was part of the course requirements for EDIM 251 and met the major goals and content of the course mandated by the Montana State Board of Education which required preservice teachers to develop competencies necessary to integrate computer technology into education. The Montana State Certification Rule 10:58:303:iii stated that teacher preparation programs "must help the student develop an awareness of the impact of computers on society and the ability to incorporate the use of the computer into the instructional process in the student's field(s) of specialization" (MAS Notice, 1982). The computer-based lesson planning task was designed in light of that charge. Complete text of the lesson planning task is included in Appendix A.

The computer-based lesson planning task was delimited by the syntax of lesson planning described in third-wave computing (Siegel & Davis, 1986; Maddux & Cummings 1986). The task required prospective teachers to integrate microcomputer technology into their content areas using the following phases of lesson planning:

1. defined what was to be taught: prospective teachers identified an aspect of their content area to be taught and developed appropriate keywords to locate resources;
2. located resources: using their keywords, prospective teachers accessed the Instructional Computing Software Database to locate a piece of software to meet their needs;
3. evaluated the software: utilizing the Northwest Lab Software evaluation form, prospective teachers evaluated their piece of software;
4. designed the lesson: objectives were written; management strategies were devised to accommodate twenty four students and twelve computers; methodologies were described for a four hour lesson; and evaluation procedures were designed (parameters were given by the course instructor).

Assessment of prospective teachers' levels of achievement on the computer-based lesson planning was based on both the degree and type of integration of computer application into the content areas.

Assessment of achievement on the computer-based lesson planning task occurred after Winter quarter 1988. Prospective teachers' computer-based tasks were rated by

the instructor and the researcher on following criteria (Siegel & Davis, 1986):

1. nature of student role in learning as evidenced by the level of objectives of the lesson;
2. nature of teacher role in learning as evidenced by the management strategy;
3. nature and level of integration of computer in the lesson as evidenced by the methodology and software evaluation.

These criteria were rated relative to the type and degree of integration of computer applications into content areas. The rating scale was designed by the researcher and the course instructor to correspond to the major characteristics described in second-wave and third-wave instructional computing (Siegel & Davis, 1986). The rating scale was as follows: 1=second-wave approach, low integration; 2=second-wave approach, high integration; 3=third-wave approach, low integration; 4=third-wave approach, high integration.

Following Winter quarter 1988, the researcher and course instructor scored and normed a sample of ten protocols chosen at random from those completed by the prospective teachers enrolled in EDIM 251 during both quarters of interest. The raters utilized the rating strategies developed by the researcher which identified

general characteristics of each level of achievement. Rating strategies were based on procedures of holistic grading and rating (Prater & Padia 1983; White, 1984; Sweedler-Brown, 1985). Complete guidelines and sample rating form are included in Appendix B.

Inter-rater reliability was calculated using the Kuder-Richardson formula suggested by Ebel (1972). The formula accounted for the following: number of independent ratings, variance of scores from a particular rater, sum of rater variances for all raters, and the sums of the ratings from all raters (Ebel, 1972, p. 419).

Assessment of Major Predictor Variables

Assessment of the two major predictor variables, level of epistemological maturity and level of computer anxiety, utilized established instruments. Each of these is discussed in terms of the following: major characteristics, reliability procedures, validity procedures, norms, and coding procedures.

Level of Epistemological Maturity

Prospective teachers' levels of epistemological maturity was assessed in the third week of each quarter of interest. The Measure of Epistemological Reflection (MER) was administered to ascertain each prospective teacher's

position on the Perry Scale of Cognitive Development (Taylor, 1984; Baxter-Magolda & Porterfield, 1985).

General Characteristics: The MER consisted of six sets of questions which addressed content area relevant to the Perry scheme. The six domain areas were as follows: decision making, role of the learner, role of the instructor in the learning process, role of peers in the learning process, evaluation systems, and the nature of truth or reality. The initial question of each domain set was general in nature and focused the respondent's attention on the specific content area. Subsequent questions were in the form of follow-up probes designed to elicit respondent's justification for his/her thinking. Responses were compared to protocols in the rating manual and a stage rating assigned. Each domain was assigned a stage rating, and the entire protocol was rated on the basis of the domain stage ratings as described below. The instrument required approximately one hour to complete (Taylor, 1984).

Reliability: The reliability of the MER was established through two procedures: establishment of inter-rater agreement and a calculation of an internal consistency coefficient. Three levels of inter-rater reliability were established: percentage of exact agreement on domain ratings, percentage of exact agreement

on total protocol ratings, and correlation of total protocol ratings. The percentage of exact agreement on domain ratings was reported to be 60%; percentage of exact agreement within one stage was reported to be 95%. Percentage of exact agreement on total protocol ratings was reported to be 75%; percentage of exact agreement on total protocol ratings within one stage was reported to be 98%. Correlation of total protocol ratings was calculated using Pearson product-moment correlation coefficients. The correlation for all protocols was reported to be .79 (Taylor, 1984).

Internal consistency of the MER was also established. Cronbach's alpha was calculated to determine the degree to which domain stage ratings were consistent with total protocol ratings. The coefficient was reported to be .74 (Taylor, 1984).

Validity: The validity of the MER was examined in terms of content validity, concurrent validity, and construct validity. Content validity was established by comparing the domains included in the MER to behaviors and attitudes associated with the Perry Scheme of Cognitive Development and with subsequent research on the Perry scheme. Concurrent validity was determined by comparing results of the MER with results of an already valid instrument: Measure of Intellectual Development

(Knefelkamp, 1974; Widick, 1977). No coefficient was reported. Construct validity was established through an analysis of variance of students' scores by level of education. Results indicated that there were significant differences in the mean level of students' scores; Scheffe post hoc multiple comparisons indicated these differences were between freshmen, seniors and graduate students (Taylor, 1984).

Norms: The MER was normed on four samples of college students: a random sample of undergraduate and graduate students at Ohio State University (N=155), a sample of undergraduate residence hall staff (N=165), a sample of undergraduate and graduate students enrolled in a college of social work (N=121), and a sample of undergraduate and graduate students in a teacher education program (N=180) (Taylor, 1984).

Coding: Students were coded on the basis of their total protocol score, each score reflecting a position on the Perry Scheme of Cognitive Development. Position rating was as follows: Position one and two were reflective of the Dualistic stage, Position three and four were reflective of the Multiplistic stage, and Position five reflected the Relativistic stage. The total protocol score reflected one of the following three possibilities: a single score, indicating all of the domains were at one

level; a weighted score, indicating that four of the six domains were at one level and two were at another level; or a split score, indicating that three domains were at one level and three domains were at another level. In order to incorporate all possible combinations, the total protocol score was derived from the mean of the domain ratings.

Rating epistemological maturity: Training for rating the Measurement of Epistemological Reflection was completed by the researcher with the authors of the instrument through their required rater training procedure. The researcher's protocol ratings were compared to expert ratings; the inter-rater reliability correlation coefficient was .87.

Level of Computer Anxiety

Prospective teachers' level of computer anxiety was assessed during the sixth week of instruction at the onset of the computer-based lesson planning task. The Computer Attitude Scale (CAS) was utilized to ascertain prospective teachers' levels of computer anxiety (Loyd & Gressard, 1984, 1985). Mean scores were derived using the Assessment Scorer, a computerized scorer developed by the course instructor.

General Characteristics: CAS was designed to measure the trait of computer anxiety as defined as the

"resistance to thinking about computer technology, fear of computers, and hostile or aggressive thoughts about computers" (Loyd & Gressard, 1984, p. 62). Forty items were included which were scored on a four point Likert scale of disagreement/agreement. Response categories ranged from strongly disagree to strongly agree. The items were designed to measure the following: computer anxiety, computer confidence, computer liking, and computer usefulness.

The forty items asked subjects a variety of positively and negatively worded statements concerning computers. A total mean score was obtained. Higher scores indicated less anxiety, more confidence, more appreciation, and greater perception of the utility of computers. Estimated time for test completion was 10 to 15 minutes.

Reliability: Reliability of the CAS was determined in two phases. The first phase involved the calculation of internal consistency coefficients for each of the three subscales and for the total score. The CAS was administered to 192 elementary, middle school and secondary teachers enrolled in a staff development program. Teachers' ages ranged from 22 to 51 years of age; gender distribution was as follows: 41 males and 151 females. Teachers' prior computer experience was minimal:

72% indicated less than a month's experience with computers. The alpha coefficients obtained were as follows: computer anxiety subscale = .89; computer confidence subscale = .89; computer liking subscore = .89; and total score = .95 (Loyd & Gressard, 1985, p. 7).

The second phase of reliability involved the examination of the degree to which the CAS reflected changes in computer attitudes with respect to instruction and experience. The sample of this phase consisted of 70 teachers of the original group of 192. Age of the teachers ranged from 22 to 51; gender distribution was as follows: 10 males and 60 females. Seventy-eight percent of the group indicated that they had had less than a month of computer experience. In this phase teachers were given the CAS at the beginning of the staff development program which provided teachers with an introduction to computer terminology, instruction in programming in BASIC, and computer-based lesson planning. At the end of the program, teachers were again given the CAS.

Alpha coefficients were calculated for subscale scores obtained in the pretest and the posttest. The results for pretest subscales were as follows: computer anxiety = .90; computer confidence = .88; and computer liking = .83. The results for posttest subscales were as

follows: computer anxiety = .88; computer confidence = .89; and computer liking = .91.

Subsequent analysis involved the following t test procedures for correlated samples. The first t test compared teachers' mean computer anxiety before and after instruction. The difference in means was found to be significant. Teachers were found to be less anxious following instruction. The second t test compared teachers' mean computer confidence before and after instruction. The difference in means was found to be significant. Teachers were more confident after instruction. The third t test compared teachers' mean computer liking before and after instruction. The difference in means was not found to be significant at the .05 level (Loyd & Gressard, 1985).

Validity: Validity for the CAS was determined through the following two procedures: factorial validity and convergent validity. Factorial validity was determined on the sample discussed under reliability. A three factor solution accounted for 54% of the total variance. The principal component analysis produced the following eigenvalues for each factor: 13.08, 1.92, and 1.21. The authors concluded that the total score was indicative of a general attitude toward computers (Loyd & Gressard, 1984; Loyd & Gressard, 1985).

The second phase of validation involved the correlation of the subscale scores on the CAS with another computer attitude inventory. The authors defined this procedure as "convergent validity." The sample for this phase consisted of 127 of the teachers discussed under reliability. The age range of these teachers was from 22 to 51; gender distribution was as follows: 29 males and 98 females. Seventy-two percent of the participants indicated less than a month's experience with computers. The alternative computer attitude inventory was a selected response inventory. Correlations between the subscales and the inventory scale were reported as follows: computer anxiety = .67; computer confidence = .60; and computer liking = .48 (Loyd & Gressard, 1985, p. 12).

Norms: As discussed, the CAS was normed on elementary, middle school, and secondary teachers. Age of the teachers ranged from 22 to 51. Gender distribution of the sample indicated more females than males. Prior computer experience level was predominately less than a month; approximately 75% of the sample indicated that level of computer experience. Generally, 13% of the sample indicated that their level of prior computer experience was less than six months (Loyd & Gressard, 1985).

Coding: CAS was scored by ascertaining the mean score of the individual item scores. Items were scaled as follows: 1=strongly disagree, 2=disagree, 4=agree, and 5=strongly agree. A high mean score on the CAS was interpreted as low level of computer anxiety; a low mean score was interpreted as high level of computer anxiety.

Assessment of Attribute Variables

Assessment of attribute variables of interest -- age, gender, class standing, level of preparation, and level of prior computer experience -- was done throughout each quarter of interest. Each of these is discussed in terms of the following: description of data source and coding procedures.

Age and Gender: Prospective teachers' ages and gender were obtained by self-report. Age and gender were included as categories in the general demographic data gathered on prospective teachers enrolled in the course. Age was coded in years. Gender was coded as follows: 1=male and 2=female.

Class standing: Prospective teachers' class standing was obtained from official class rolls. Class standing was coded as indicated in the Montana State University Undergraduate Catalog:

1=Freshman (less than 45 credits earned);

2=Sophomore (more than 45 and less than 90 credits earned);

3=Junior (more than 90 and less than 135 credits earned);

4=Senior (more than 135 credits earned);

5=Post Baccalaureate (more than 192 credits earned)

Level of prior computer experience: Assessment of prospective teachers' levels of computer experience was obtained by student self-report at the beginning of each quarter of interest. Level of computer experience was coded in correspondence with the levels identified on the CAS:

1=one week or less of computer experience;

2=one week to one month of computer experience;

3=one month to six weeks of computer experience;

4=six weeks to six months of computer experience;

5=six months to one year of computer experience;

6=one year or more of computer experience.

Level of preparation: Assessment of prospective teachers' level of preparation was obtained from official class rolls during the quarters of interest. Coding required introduction of two dummy variables which were coded as follows (Pedhazur, 1982):

Elementary preparation: ELED=1 and SCED=0

Secondary preparation: ELED=0 and SCED=1

Those prospective teachers who were coded into K-12 options were identified as those prospective teachers coded as 0 in both variables.

Statistical Hypotheses

In order to determine whether second- or third-wave achievement on a computer-based lesson planning task could be predicted from the given set of predictor and attribute variables, the following hypotheses were tested:

1. There were no significant differences in mean levels of computer anxiety between males and females;
2. There were no significant differences in mean levels of computer anxiety among the six levels of prior computer experience;
3. There was no interaction between gender and levels of prior computer experience with respect to mean level of computer anxiety;
4. There were no significant differences in mean levels of epistemological maturity between males and females;
5. There were no significant differences in mean levels of epistemological maturity between traditional-aged and nontraditional-aged prospective teachers;
6. There was no interaction between gender and age with respect to mean levels of epistemological maturity;
7. There was no significant R-Square between the set of predictor and attribute variables and the criterion variable of achievement.

8. The raw score weights associated with level of epistemological maturity, level of computer anxiety, age, gender, class standing, level of preparation, and level of prior computer experience were not significantly greater than 0.
9. No significant increments to R-Square were associated with the inclusion of the independent variables of level of epistemological maturity, level of computer anxiety, age, gender, class standing, level of preparation, and level of prior computer experience in the regression model.

Methods of Data Analysis

Several methods of data analysis were utilized to test the hypotheses. Each hypothesis is discussed in terms of the following:

1. discussion of Type I and Type II errors;
2. statistic used;
3. tests of significance used;
4. statistical software utilized.

Controlling Type I and Type II Errors

Controlling Type I and Type II errors in statistical research is a function of both choice of the alpha level of significance as well as of sample size. Type I error, the error of rejecting a true null hypothesis, could have been controlled by the choice of alpha. On the other hand, Type II error, the error of accepting a false null hypotheses, could have been controlled by sample size (Ferguson, 1981, p. 174-175).

In the study, control over these errors was a function of the choice of alpha. The use of intact classes and time constraints did not allow for control of Type II error through increased sample sizes. Hence, the choice of alpha was based on the consequences of committing Type I and Type II errors and on the impact of those consequences on the integrity of the study.

The choice of the .05 level of significance was based on the rationale that the consequences of committing a Type I or a Type II error were equally detrimental to the integrity of the study. Therefore, the researcher considered interpreting results with 95% confidence acceptable for the study based on the notion that alpha .05 is the conventional choice when the consequences of committing a Type I or a Type II are considered equally detrimental (Ferguson, 1981, p. 175).

Testing Mean Differences: Computer Anxiety

- Hypothesis: There were no significant differences in mean levels of computer anxiety between males and females;
- Hypothesis: There were no significant differences in mean levels of computer anxiety among the six levels of prior computer experience;
- Hypothesis: There was no interaction between gender and levels of prior computer experience with respect to mean level of computer anxiety.

In order to determine whether the mean levels of computer anxiety were significantly different with respect

to gender and level of prior computer experience, a Two-Way Analysis of Variance was performed. The statistical significance of the F ratio was tested at the .05 level. 'Scheffe' post hoc multiple comparisons were performed to determine significant differences of mean levels of computer anxiety with respect to the six levels of prior computer experience. The SPSSX statistical package was utilized to perform the necessary calculations.

Testing Mean Differences: Epistemological Maturity

- Hypothesis: There were no significant differences in mean levels of epistemological maturity between males and females;
- Hypothesis: There were no significant differences in mean levels of epistemological maturity between traditional-aged and nontraditional-aged prospective teachers;
- Hypothesis: There was no interaction between gender and age with respect to mean levels of epistemological maturity.

In order to determine whether the mean levels of epistemological maturity were significantly different with respect to gender and age, a Two-Way Analysis of Variance was performed. The statistical significance of the F ratio was tested at the .05 level. The SPSSX statistical package was utilized to perform the necessary calculations.

Testing for Prediction

In order to determine extent to which second- or third-wave achievement on a computer-based lesson planning task could be predicted from the given set of predictor and attribute variables, three levels of data analysis were performed. These were based on the three goals of multiple regression suggested by Kerlinger and Pedhazur (1973, p. 34):

1. to determine the "proportion of the variance that the regression equation 'accounts for'";
2. to determine "whether each regression coefficient, b , in the regression equation is statistically different from zero";
3. to determine "whether the regression of Y on the X's, the relationship between Y and the 'best' linear combination of the X's is statistically significant."

Each of these goals is expressed as an hypothesis and appropriate statistical analysis discussed. The SPSSX statistical package was utilized to perform the necessary calculations. Procedures for validating the regression model are also addressed.

Determining the Proportion of the Variance: The following hypothesis was tested:

Hypothesis: There was no significant R-Square between the set of predictor and attribute variables and the criterion variable of achievement.

In order to determine the proportion of the variance in the dependent variable of achievement which could be accounted for by the regression equation, R-Square was calculated using the formula suggested by Pedhazur (1982, p. 56). The statistical significance of R-Square was tested using the F ratio test at the .05 level.

Determining the Significance of the Independent Variables: The following hypotheses was tested:

Hypothesis: The raw score weights associated with level of epistemological maturity, level of computer anxiety, age, gender, class standing, level preparation, and level of prior computer experience were not significantly greater than 0.

In order to determine the contribution of each of the independent variables in the prediction of the dependent variable of achievement, the statistical significance of the raw score weights associated with those independent variables were tested. The statistical significance of the raw score weights were tested using the t test at the .05 level using the procedure suggested by Pedhazur (1982, p. 61).

Determining the Significant Increments in R-Square:

The following hypothesis was tested:

Hypothesis: No significant increments to R-Square were associated with the inclusion of the independent variables of level of epistemological maturity, level of computer anxiety, age, gender, class standing, level of preparation, and level of prior computer experience in the regression equation.

In order to determine the "relative efficacies of different variables in the regression equation" (Kerlinger & Pedhazur, 1973, p. 71), a stepwise solution of the regression equation was utilized. Using this procedure entailed the systematic inclusion of independent variables into the regression and the subsequent testing of significant increments in R-Square (Kerlinger & Pedhazur, 1973, p. 285-288). Testing for the significant increments in R-Square utilized the F ratio test at the .05 level.

Validation of the Model: Kerlinger and Pedhazur suggested that one of the major limitations of multiple regression analysis was the "unreliability of the regression weights" (1973, p. 442). This unreliability was identified as a function of both sample size and intercorrelations among independent variables. In order to address this problem, the double cross-validation procedure was utilized to estimate the shrinkage in R-Square. Kerlinger and Pedhazur suggested, in fact, that

"double-cross validation is strongly recommended as the most rigorous approach to the validation of results from regression analysis in a predictive framework" (1973, p. 284).

The double-cross validation method, developed by Mosier (1951), involved the following steps:

1. At the end of Winter quarter 1988, the entire sample was randomly divided into two equal subsamples by keying computer-generated random numbers to student identification numbers;
2. R-Square and the regression equation were calculated for each subsample;
3. Each regression equation obtained in one sample was applied to the predictor variables of the other sample;
4. An $r_{yy'}$ was calculated for each subsample and the difference noted.

As suggested the differences between the two $r_{yy'}$'s were compared. The regression equation was subsequently calculated on the entire sample (Pedhazur, 1982, p. 150).

CHAPTER 4

FINDINGS AND INTERPRETATIONS

The problem of this study was to determine if second- or third-wave achievement on a computer-based lesson planning task in a required teacher preparation computer course at Montana State University could be predicted from knowledge of the following set of prospective teacher variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. The attribute variables of interest included age, gender, class standing, level of preparation, and level of prior computer experience.

Data collected are presented as follows:

1. Comparative sample and population data;
2. Inter-rater reliability data;
3. Independent variable data;
4. Regression data.

Comparative Sample and Population Data

The population for the study included all Montana State University students coded in one of the teacher preparation or teacher certification curricula during Autumn quarter 1987 or Winter quarter 1988.

The sample consisted of 212 prospective teachers who were enrolled in EDIM 251 during Autumn quarter 1987 or Winter quarter 1988. The subjects for the study were not chosen at random; therefore, the sample and population were compared to determine any significant deviations relative to the following variables of interest: gender, class standing, and age.

Population and Sample Gender Distribution

The gender distribution of the population was determined from enrollment data supplied by the Montana State University Registrar's Office. These data were used to establish the expected proportion of males and females. A summary of the population data is included in Table 15, Appendix C. The gender distribution of the sample was determined from official class rolls and constituted the observed number of males and females. The sample distribution was compared to the population distribution using a Chi-Square goodness of fit procedure (Ferguson, 1981, p. 206). Table 1 illustrates the results of the goodness of fit test.

Table 1. Gender Goodness of Fit.

Gender	O	S%	P%	E	O-E	$\frac{(O-E)^2}{E}$
Male	66	31.13%	36.17%	76.68	-10.68	1.49
Female	146	68.87%	63.83%	135.32	10.68	.84
	212	100.00%	100.00%	212.00	0	2.33

Ho: Sample gender distribution was the same as the population gender distribution.

Test: Critical value of Chi-Square equaled 3.84 with $\alpha = .05$ and $DF = 1$. Computed Chi-Square equaled 2.33. Computed Chi-Square was less than critical value of Chi-Square.

Decision: The null hypothesis was retained; sample gender distribution did not deviate significantly from the expected population gender distribution.

Population and Sample Class Standing Distribution

The class distribution of the population was determined from enrollment data supplied by the Montana State University Registrar's Office. These data were used to establish the expected proportion of prospective teachers in each of the five class categories: Freshman (1), Sophomore (2), Junior (3), Senior (4), and Graduate (5). A summary of the population data is included in Table 16, Appendix C. The class standing distribution of

the sample was determined from official class rolls and constituted the observed number of students in each of the five class categories. The sample distribution was compared to the population distribution using a Chi-Square goodness of fit procedure (Ferguson, 1981, p. 206). Table 2 illustrates the results of the procedure.

Table 2. Class Standing Goodness of Fit.

Class	O	S%	P%	E	O-E	$\frac{(O-E)^2}{E}$
Fr (1)	9	4.25%	19.20%	40.70	-31.70	24.69
So (2)	58	27.36%	18.00%	38.16	19.84	10.32
Jr (3)	51	24.06%	19.40%	41.13	9.87	2.37
Sr (4)	72	33.96%	34.30%	72.72	-.72	.01
Gr (5)	22	10.38%	9.10%	19.29	2.71	.38
	-----	-----	-----	-----	-----	-----
	212	100.00%	100.00%	212.00	0	37.77

Ho: Sample class distribution was the same as the population class distribution.

Test: Critical value of Chi-Square equaled 9.29 with $\alpha = .05$ and $DF = 4$. Computed Chi-Square equaled 37.77. Computed Chi-Square was greater than critical value of Chi-Square.

Decision: The null hypothesis was not retained; sample class distribution did deviate significantly from the population class distribution.

However, it must be noted that EDIM 251, Foundations of Instructional Computing, was tabulated as a sophomore

level course in the Montana State University Undergraduate Catalog. Therefore, it was expected that freshmen would be underrepresented in the sample. A subsequent Chi-Square goodness of fit test was applied to the sample exclusive of the nine freshmen who had enrolled in the course. Table 3 illustrates the results of the procedure.

Table 3. Class Standing Goodness of Fit Exclusive of Freshmen.

Class	O	S%	P%	E	O-E	$\frac{(O-E)^2}{E}$
So (2)	58	28.57%	22.30%	45.27	12.73	3.58
Jr (3)	51	25.12%	24.00%	48.72	2.28	.11
Sr (4)	72	35.47%	42.50%	86.27	-14.27	2.36
Gr (5)	22	10.84%	11.20%	22.74	-.74	.02
	-----	-----	-----	-----	-----	-----
	203	100.00%	100.00%	203.00	0	6.07

Ho: Sample class distribution, excluding freshmen, was the same as the population class distribution, excluding freshmen.

Test: Critical value of Chi-Square equaled 7.82 with $\alpha = .05$ and $DF = 3$. Computed Chi-Square equaled 6.07. Computed Chi-Square was less than critical value of Chi-Square.

Decision: The null hypothesis was retained; sample class distribution did not deviate significantly from the population class distribution when freshmen were excluded.

Population and Sample Mean Age

The mean age of the population was determined from enrollment data supplied by the Montana State University Registrar's Office. These data indicated that the mean age of the population was 24.53. A summary of the population data is included in Table 17, Appendix C. The mean age of the sample was determined from student self-report data. The mean age of the population and the mean age of the sample were compared using the t test for single sample (Ferguson, 1981). Table 4 illustrates the results of that procedure.

Table 4. Comparison of Mean Age of Sample and Population.

Pop Mean	Sample Mean	SE Mean	.95 Lower	.95 Upper	T	P- Value
24.53	24.76	.4164	23.94	25.58	.5503	.5821

Ho: Sample mean age was not significantly different from population mean.

Test: Critical value of t equaled 1.960 with alpha = .05 and DF = 211. Computed t equaled .5503.

Decision: The null hypothesis was retained; sample mean age did not deviate significantly from mean age of the population.

Inter-Rater Reliability DataRating Achievement

Following Winter quarter 1988, the researcher and course instructor scored and normed a sample of ten protocols chosen at random from those completed by the prospective teachers enrolled in EDIM 251 during both quarters of interest. Protocol scores ranged from 1 to 4. Inter-rater reliability was calculated using the Kuder-Richardson formula which accounted for the following: number of independent raters, variance of scores from a particular rater, sum of rater variances for all raters, and the sums of the ratings from all raters (Ebel, 1972, p. 419). Table 5 includes summary results and the inter-rater reliability correlation coefficient. Data utilized in the procedure are included in Table 18, Appendix C.

Table 5. Project Inter-Rater Reliability Coefficient.

Rater	Protocol										TOT
	A	B	C	D	E	F	G	H	I	J	
1	4	2	1	1	3	2	4	3	1	1	22
2	3	1	1	1	3	2	3	4	1	1	20
	7	3	2	2	6	4	7	7	2	2	42
Variance											Reliability
Total score	= 4.76										r = .92
Sum Item	= 2.56										

Rating epistemological maturity

Rater training for the Measurement of Epistemological Reflection was completed by the researcher with the authors of the instrument through their required rater training procedure. The researcher's ratings were compared to expert ratings; the inter-rater reliability correlation coefficient was .87.

Independent Variables

As indicated in the review of the literature, there have been a number of studies which have discussed the differences among subjects relative to several independent variables of interest. In particular, several studies have indicated that the factors of gender and prior computer experience were related to differences in subjects' degree of computer anxiety (Fetler, 1985; Hawkins, 1985; Wilder & Mackie, 1985; Schubert, 1986). Also, several studies have indicated that the factors of gender and age were related to differences in subjects' epistemological maturity (Perry, 1970; Clinchy, et al, 1977; Cameron, 1984; Clinchy & Zimmerman, 1982; Belenky, et al, 1986; Baxter-Magolda, 1987). The following analyses addressed those differences.

Mean Differences in Computer Anxiety

In order to determine if there were significant differences in mean levels of computer anxiety (CAS) with respect to gender (MF) and to levels of prior computer experience (EXP), a Two-way Analysis of Variance (ANOVA) procedure was utilized (Ferguson, 1981). Table 6 provides a summary of cell means. Table 7 illustrates the results of the ANOVA analysis.

Table 6. Cell Means: CAS by MF and EXP.

Gender	Experience					
	1	2	3	4	5	6
M	3.02	3.53	3.05	3.43	3.26	3.38
F	3.11	3.22	3.08	3.25	3.26	3.38

Table 7. ANOVA: CAS by MF and EXP.

Source of Variation	Sum of Squares	DF	Mean Square	F	P-Value
Main Effects					
MF	0.086	1	0.086	0.565	0.453
EXP	2.886	5	0.577	3.776	0.003*
Interaction	0.647	5	0.129	0.847	0.518
Residual	3.674	200	0.153		

* Significant at the .05 level

Ho: There were no significant differences in mean levels of computer anxiety between males and females.

Test: There were no significant differences in mean levels of computer anxiety with respect to gender at the .05 level.

Decision: Null hypothesis was retained.

Ho: There were no significant differences in mean levels of computer anxiety among the six levels of prior computer experience.

Test: There were significant differences in mean levels of computer anxiety with respect to prior computer experience at the .05 level.

Multiple Comparison: A Scheffe' multiple comparison indicated at the .05 level there were significant differences between the mean computer anxiety of those students with one week or less of prior computer experience and those students with one year or more of computer experience. Recalling that a high score on the CAS reflected a low level of computer anxiety, it was concluded that those prospective teachers who had had the most prior computer experience demonstrated significantly less computer anxiety than those prospective teachers with one week or less of prior computer experience. Summary data of the Scheffe' multiple comparison are included in Tables 19 and 20, Appendix C.

Decision: The null hypothesis was not retained; there were significant differences in mean levels of computer anxiety with respect to prior computer experience.

Ho: There was no interaction between gender and levels of prior computer experience with respect to mean level of computer anxiety.

Decision: The null hypothesis was retained; there was no significant interaction.

Mean Differences in Epistemological Maturity

In order to determine if there were significant differences in mean levels of epistemological maturity (MER) with respect to gender (MF) and age (AGE), a Two-way ANOVA was performed (Ferguson, 1981). Age was recoded into two categories: Traditional (subjects 23 years old or younger) and Nontraditional (subjects older than 23 years). Table 8 provides a summary of cell means. Table 9 illustrates the results of the ANOVA analysis.

Table 8. Cell Means: MER by MF and AGE.

Gender	Age	
	Trad	NTrad
M	2.77	3.11
F	2.91	3.16

Table 9. ANOVA: MER by MF and AGE.

Source of Variation	Sum of Squares	DF	Mean Square	F	P-Value
Main Effects					
MF	0.365	1	0.365	0.875	0.351
AGE	4.063	1	4.063	9.741	0.002*
Interaction	0.073	1	0.073	0.175	0.676
Residual	86.753	208	0.417		

* Significant at the .05 level.

Ho: There were no significant differences in mean levels of epistemological maturity between males and females.

Test: There were no significant differences in mean levels of epistemological maturity with respect to gender at the .05 level.

Decision: The null hypothesis was retained.

Ho: There were no significant differences in mean levels of epistemological maturity between traditional-aged and nontraditional-aged prospective teachers.

Test: There were significant differences in epistemological maturity with respect to age at the .05 level.

Decision: The null hypothesis was not retained; there were significant differences in mean epistemological maturity with respect to age. The mean level of epistemological maturity for traditional-aged prospective

teachers (mean = 2.84) was significantly lower than the mean level of epistemological maturity for nontraditional-aged prospective teachers (mean = 3.13).

Ho: There was no interaction between gender and age with respect to mean levels of epistemological maturity.

Decision: The null hypothesis was retained; there was no significant interaction.

Regression Findings

In order to account for the variance in achievement on a computer-based lesson planning task from knowledge of several independent variables, a regression analysis was conducted. The findings are presented as the follows:

1. Descriptive Statistics relative to variables of interest;
2. Analysis of Variance table for the regression equation;
3. Analysis of Raw Score Weights;
4. Stepwise Regression Findings;
5. Validation of the Model.

Descriptive Statistics

Table 10 illustrates the descriptive statistics of the independent variables which were categorical in nature. These included: level of preparation (ELED,

SCED, and K-12); gender (M and F); and class standing (CLS).

Table 10. Categorical Independent Variables.

Variable	Value	Frequency	Percent
ELED	1	100	47.16%
SCED	1	89	41.98%
K-12	0	23	10.84%
M	1	66	31.13%
F	2	146	68.87%
CLS (1)	1	9	4.25%
CLS (2)	2	58	27.36%
CLS (3)	3	51	24.06%
CLS (4)	4	72	33.96%
CLS (5)	5	22	10.38%

Table 11 illustrates the descriptive statistics of the independent variables which were continuous in nature. These included: age (AGE), level of prior computer experience (EXP), level of epistemological maturity (MER), level of computer anxiety (CAS), and the dependent variable of achievement (PRJ).

Table 11. Continuous Independent Variables.

Variable	N	Min.	Max.	Mean	Std Dev.
AGE	212	19	49	24.76	6.063
EXP	212	1	6	3.54	1.886
MER	212	1.67	5.00	3.00	.657
CAS	212	2.05	4.00	3.24	.403
PRJ	212	1.00	4.00	1.81	.792

The preceding data are useful in visualizing the ways in which categorical and continuous variables of interest were distributed in the sample. Additional frequency distributions illustrating the relationships among the predictor variables and between the major predictor variables and the criterion variable of achievement are included in Tables 21 through 24 in Appendix C.

Regression Analysis

Significance of R-Square

The first step in the regression analysis was to determine if there were a significant R-Square between the set of predictor and attribute variables and the criterion variable of achievement (PRJ). A regression equation was generated, entering all of the predictor variables. Table 12 illustrates the Analysis of Variance data generated by the full model regression.

Table 12. Full Model: Dependent Variable is PRJ.

Source of Variation	DF	Sum of Squares	Mean Square	F	p-Value
Regression	8	46.12535	5.76567	13.558	.0000*
Residual	203	86.32748	.42526		
R-Square = .34824 Adj. R-Square = .3225 SE = .65212					

* Significant at the .05 level.

Ho: There was no significant R-Square between the set of predictor and attribute variables and the criterion variable of achievement.

Test: R-Square of .34824 was significantly greater than zero. The R-Square of .34824 indicated that approximately 35% of the variance in the dependent variable of achievement could be accounted for by knowledge of the set of predictor and attribute variables at the .05 level.

Decision: The null hypothesis was not retained; R-Square was significantly greater than zero.

Significance of Raw Score Weights

The second step in the regression analysis was to determine if the raw score weights associated with each independent variable were significantly greater than zero. The raw score weights associated with level of epistemological maturity (MER), level of computer anxiety (CAS), age (AGE), gender (MF), class standing (CLS), level of preparation (ELED and SCED), and level of prior computer experience (EXP) are presented in Table 13.

Table 13. Significance of Raw Score Weights: Dependent Variable is PRJ.

Variable	b	SE b	T	Prob> T
MER	.583577	.072321	8.069	.0000*
CAS	-.205305	.117534	-1.747	.0822
AGE	.019754	.008316	2.375	.0185*
MF	.050439	.105041	0.480	.6316
CLS	.052259	.050155	1.042	.2987
ELED	-.132575	.157822	-0.840	.4019
SCED	-.122283	.155408	0.787	.4323
EXP	-.005137	.025772	-0.199	.8422
Constant	.116319	.515908		

* Significant at the .05 level

Ho: The raw score weights associated with level of epistemological maturity, level of computer anxiety, age, gender, class standing, level of preparation, and level of prior computer experience were not significantly greater than 0.

Test: Raw score weights associated with level of epistemological maturity (MER) and age were significantly greater than 0 at the .05 level.

Decision: The null hypothesis was not retained; raw score weights of MER (.583577) and AGE (.019754) were significantly greater than 0.

Stepwise Solution

The third step in the regression analysis was to examine the relative contributions of the independent variables to the overall R-Square. Because raw score weights were not comparable because of variation in methods of measurement, stepwise regression was utilized to determine the "best set" of predictors: those independent variables which contribute to significant increments in R-Square. Table 14 illustrates the significant increments in R-Square associated with systematic inclusion and/or exclusion of the set of independent variables. Complete analysis of variance data is included in Table 25, Appendix C.

Table 14. Stepwise Model: Dependent Variable is PRJ.

Step	Var In/Out	No. In	Partial R**2	Model R**2	F	Prob> F
1	MER	1	.654640	.29444	87.64	.0000*
2	AGE	2	.025034	.32944	51.34	.0000*

* Significant at the .05 level

Ho: No significant increments to R-Square were associated with the inclusion of the independent variables of level of epistemological maturity, level of computer anxiety, age, gender, class standing, level of preparation, and level of prior computer experience in the regression equation.

Test: Stepwise inclusion of the independent variables of epistemological maturity and age resulted in significant increments to R-Square at the .05 level.

Decision: The null hypothesis was not retained; inclusion of MER and AGE resulted in significant increments to R-Square.

Validation of the Model

In order to address the problem that R-Square was an artifact of this particular sample, the double cross-validation procedure was utilized to estimate the shrinkage in R-Square. The double-cross validation method, developed by Mosier (1951), involved the following steps:

1. The total sample of 212 prospective teachers was divided at random into two equal-sized subsamples. A regression equation was generated for each subsample. R-Square for subsample A equaled .39427 (ADAW). R-Square for subsample B equaled .35223 (BDBW).
2. Regression equation A was applied to the B data (BDAW) and the regression equation B was applied to the A data (ADBW), yielding two sets of Y-primes. The PRJ scores from subsample A were correlated with the predicted PRJ scores from the

ADBW regression. The Pearson correlation coefficient $r_{yy'}$ (A) equaled .5514 (R-Square = .3040). The PRJ scores from subsample B were correlated with the predicted PRJ scores from the BDAW regression. The Pearson correlation coefficient $r_{yy'}$ (B) equaled .5185 (R-Square = .2688). Both Pearson correlation coefficients had p-values of .0000.

Examination of the double cross-validation procedure indicated that the shrinkage in R-Square, demonstrated by the difference between $r_{yy'}$ (A) and $r_{yy'}$ (B), was minimal.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The problem of this study was to determine if second- or third-wave achievement on a computer-based lesson planning task in a required teacher preparation computer course at Montana State University could be predicted from knowledge of the following set of prospective teacher variables: level of epistemological maturity, level of computer anxiety, and selected attribute variables. A summary of this study is presented as follows:

1. General summary of sampling and procedures;
2. Conclusions of findings relative to the affective domain;
3. Recommendations for further research in the affective domain;
4. Conclusions of findings relative to the epistemological domain;
5. Recommendations for further research in the epistemological domain;
6. Recommendations for Pre-Service Teacher Education.

Summary of the Study

This study was designed to examine characteristics of prospective teachers which might be useful in predicting the type and level of integration of computer technology proposed by prospective teachers in their content areas. Previous research indicated that teachers tended toward two approaches of instructional computing. The second-wave approach entailed using the computer either for games or for reinforcement of traditional methods of instruction. The third-wave approach entailed using the computer for non-traditional methods of instruction to maximize the power of the computer for higher level problem-solving and reflective judgment (Siegel & Davis, 1986; Maddux & Cummings, 1986; Bowers, 1988).

Research indicated that teachers' tendencies toward one of these two approaches could be related to their affective responses to technology as well as to their epistemological views of information processing and the learning/teaching process. Therefore, this study examined the affective and epistemological characteristics of a sample of prospective teachers at Montana State University to determine the degree to which these tendencies could be predicted from the knowledge of affective, epistemological and attribute characteristics of the prospective teachers.

The population of this study consisted of those prospective teachers enrolled in one of the teacher preparation or certification options at Montana State University during Autumn quarter 1987 (N = 1200) or Winter quarter 1988 (N = 1223). The sample consisted of 212 prospective teachers who enrolled in EDIM 251, Foundations of Instructional Computing, during the quarters of interest.

The predictor variables chosen for this study were selected from the following three categories: affective, epistemological and attribute. The affective variable was defined as level of computer anxiety and was assessed using the Computer Attitude Scale developed by Loyd and Gressard (1984). Subjects' mean score on the forty-item scale was entered into the regression. A high score on the CAS was interpreted as a low degree of computer anxiety.

The epistemological variable was defined as level of epistemological maturity and was assessed using the Measure of Epistemological Reflection developed by Baxter-Magolda and Porterfield (1985). The mean score of the six domains of the protocol was entered into the regression. The score reflected the subjects' positions on the Perry Scale of Cognitive Development (Perry, 1970).

The attribute variables included were as follows: gender, age, class standing, level of preparation, and level of prior computer experience. These were coded from both official class roll information as well as from subject self-report. Decision to include these variables was based upon both the research as well as on the nature of the population studied. Gender, age and level of prior computer experience were included because prior research had shown these factors had contributed to differential performance relative to both affective and epistemological measures. Level of preparation and class standing were included as cross references to other variables.

The criterion variable for this study was defined as the achievement score on the computer-based lesson planning task. This task was designed by the researcher and the instructor of EDIM 251 and focused on the type and level of integration of computer technology proposed by prospective teachers. The computer-based lesson planning project was designed to assess both the type of application proposed by the subjects as well as the degree of integration of computer technology into the content areas.

The purpose of this study was to address the following general questions:

1. Did mean levels of computer anxiety differ with respect to gender and/or level of prior computer experience?
2. Did mean levels of epistemological maturity differ with respect to gender and age?
3. To what extent could second- or third-wave achievement on a computer-based lesson planning task be predicted from the knowledge of prospective teachers' level of epistemological maturity, level of computer anxiety, gender, age, class standing, level of preparation, and level of prior computer experience?
4. Which of the predictor variables contributed significantly to prediction of the criterion variable of achievement?
5. Which of the predictor variables constituted the "best set" of predictors?

Conclusions: Affective Domain

Examination of the findings relative to the affective domain resulted in the following conclusions:

1. Gender was not a significant factor in relation to mean levels of computer anxiety. These findings did

not concur with the research that has suggested adaptation to and acceptance of technology were gender-specific, that males appeared to be more receptive to computer technology than females (Fetler, 1985; Hawkins, 1985; Wilder & Mackie, 1985). Rather in this study, both males and females demonstrated low levels of computer anxiety as demonstrated by their high scores on the CAS, and there were no significant differences between the male and female mean levels of computer anxiety.

2. Level of prior computer experience was a significant factor in relation to mean levels of computer anxiety. Those subjects with one week or less of prior computer experience demonstrated significantly higher levels of computer anxiety than those prospective teachers with one year or more of prior computer experience. Levels of prior computer experience appeared to be related to prospective teachers' levels of computer anxiety. These findings concurred with other studies which concluded that exposure to technology was related to levels of computer anxiety (Jay, 1981; Cambre & Cook, 1985).

3. However, the overall knowledge of level of computer anxiety did not contribute significantly to the prediction of achievement on the computer-based lesson planning task. In fact, an examination of the

correlations and distributions of the variable of computer anxiety revealed an inverse relationship between levels of computer anxiety and achievement on the computer-based lesson planning task. Those subjects who scored high on the CAS and demonstrated low levels of computer anxiety were more apt to indicate that they would use the computer either in a game mode or in conjunction with traditional methods of instruction (second-wave applications). These findings challenge the prevalent notion in curriculum development that teachers with lower levels of computer anxiety were more apt to integrate technology into their content areas in innovative ways (Jay, 1981; Rawitsch, 1982). On the contrary, the findings support the notion that lower levels of computer anxiety were not sufficient to promote third-wave applications of instructional computing.

Recommendations For Further Research:
Affective Domain

Based on the findings in the affective domain, the researcher recommends the following:

1. It would be appropriate to study further the variable of level of computer anxiety. Examination of the findings in this study indicated that there was little variation in subjects' responses to the CAS. The mean score equaled 3.24 with a standard deviation of .403. On

the average the subjects were not anxious about computers, and their scores were closely clustered around the mean. Few subjects demonstrated extremely low or extremely high levels of computer anxiety. Additional studies which incorporated subjects with more varied levels of computer anxiety might demonstrate that level of computer anxiety was a significant variable of prediction.

2. It would also be appropriate to study further the nature of prospective teachers' prior computer experiences. The following relationship was not addressed in this study: Whether a certain kind of prior computer experience was related to less computer anxiety or whether simply being exposed to the technology was sufficient impetus to reduce anxiety.

Conclusions: Epistemological Domain

Examination of the findings relative to the epistemological domain resulted in the following conclusions:

1. Gender was not a significant factor in relation to mean levels of epistemological maturity. These findings did not concur with the research that has suggested one of the limitations of the Perry research was that it was biased toward females (Belenky, et al, 1986). Rather in this study, there were no significant

differences between males and females with respect to their levels of epistemological maturity as demonstrated by their scores on the MER.

2. Age was a significant factor in relation to mean levels of epistemological maturity. In fact, findings which indicated that traditional-aged prospective teachers demonstrated significantly lower levels of epistemological maturity than nontraditional-aged prospective teachers helped to validate the developmental nature of the Perry Scale of Cognitive Development (Perry, 1970). It would be difficult to justify the notion that adults progress through higher levels of epistemological reflection if findings had demonstrated no significant differences.

3. The overall knowledge of the set of predictor and attribute variables did contribute significantly to the prediction of achievement on the computer-based lesson planning task. In fact, nearly 35% of the variation in achievement was associated with the set of variables. A more in depth look at the findings indicated that a disproportionate amount of the 35% was attributed to level of epistemological maturity.

4. Specifically, the only variables which contributed significantly to the overall prediction were knowledge of level of epistemological maturity and age. These two variables constituted the "best set" of

predictors. In fact, of the 35% of the variance accounted for, nearly 84% of that could be attributed to level of epistemological maturity. An examination of the distribution of level of epistemological maturity and achievement indicated that those subjects who were at the lower levels of epistemological maturity designed lessons which were overwhelmingly second-wave in nature. On the other hand, a majority of those subjects who were at higher levels of epistemological maturity designed lessons which were third-wave in nature. It would appear that the "developmental phenomenology" (Perry, 1970) of prospective teachers was significantly related to their choice of second-wave or third-wave integration of computer technology. The findings also supported the notion that, insofar as epistemology is a philosophical construct, the decision to opt for second-wave or third-wave integration of computer technology was philosophical in nature (Davies & Shane, 1986; Bowers, 1988).

Recommendations for Further Research:
Epistemological Domain

Based on the findings in the epistemological domain, the significant contribution of the epistemological variable to prediction of achievement on the computer-based lesson planning task should prompt further extensive research on the relationship between

epistemological maturity and teacher preparation in the area of instructional computing. The researcher recommends the following facets of the relationship be examined:

1. It would be appropriate to further study the variable of level of epistemological maturity and achievement. Examination of the findings in this study indicated that there was little variation in subjects' responses to the MER. A majority (86%) of the subjects were at the Dualistic and Multiplistic stages on the Perry Scale of Cognitive Development; few (14%) demonstrated Relativistic levels of epistemological maturity. Likewise, a majority (83%) of the subjects indicated that they would use predominately second-wave computer applications; few (17%) indicated they would use third-wave computer applications. Additional studies which incorporated subjects with more varied levels of epistemological maturity would be required to verify the significance of the relationship demonstrated in this study.

2. It would also be appropriate to compare and contrast the distribution of this study with the distribution of other studies incorporating epistemological maturity and to isolate the characteristics of programs which produce higher levels of

epistemological maturity. For example, the findings of this study indicated that even though 34% of the sample were seniors, a majority of the subjects were at the lower stages (1-3) of epistemological maturity. In contrast, Perry and others have indicated that in their studies a majority of college freshmen were generally moving out of the Dualistic stage (1-2) into the Multiplicistic stage (3-4) and that a majority of the seniors had reached the Relativistic stage (5) (Perry, 1970; Knefelkamp, 1974; Knefelkamp & Slepitz, 1976; Kurfiss, 1977).

2. One of the limitations of this study was the fact that it utilized a population from a single institution. It is recommended that additional research be conducted which involves other instructional computing components of teacher preparation programs throughout the country. Such research would preclude the development and validation of an instrument to measure prospective teachers' propensities to utilize second-wave or third-wave computer applications. It would not be feasible to export the computer-based lesson planning project to other programs. It is conceivable that the components of the project could be converted to a paper and pencil instrument which would assess teachers' perceptions of computer integration.

3. Another limitation of this study was that it focused exclusively on a population of prospective

teachers. That is, the ways in which prospective teachers projected they would integrate computer technology was examined. It would be appropriate to suggest that these prospective teachers be tracked once they are in the field to determine the following: any changes in subjects' level of epistemological maturity once they have been in the field; examination of whether there is a relationship between level of epistemological maturity and the choice to actually integrate computer technology into the content areas; and examination of the relationship between level of epistemological maturity and the level and type of integration of instructional computing in the field.

4. It is recommended that the study of epistemological maturity be extended to other realms of teacher preparation. It would be appropriate to study prospective teachers' epistemological maturity in relation to the components of teaching in general: the perception of student role in learning as evidenced by the level of objectives of instructional planning, the perception of teacher role in learning as evidenced by management strategies, the nature of methodologies employed, and the nature of evaluation employed. Ultimately, it is suggested that the study of teachers' epistemological maturity in relation to levels of student achievement be studied at length.

Recommendations for Pre-Service Teacher Education

With respect to the affective domain, the researcher suggests the following recommendations be considered in the design and implementation of teacher preparation curriculum in the area of instructional computing:

1. The premise that lower levels of computer anxiety would be sufficient to promote third-wave applications of instructional computing should be re-examined. It did not appear that simply requiring all prospective teachers to be exposed to computer technology ensured that they would opt for third-wave integration of computer technology into their content areas.

2. It is recommended that curriculum design in instructional computing focus more on the epistemological issues of higher level thinking and less on the affective issues of computer anxiety. Computer anxiety did not appear to interfere with prospective teachers' choices for second- or third-wave computer applications.

With respect to the epistemological domain, the researcher suggests the following recommendations be considered in the design and implementation of teacher preparation curriculum:

1. It is recommended that the catalysts which research has shown to affect epistemological maturity

progression (Perry, 1970; Knefelkamp, 1974; Widick, 1977) be systematically integrated into the curriculum of EDIM 251, Foundations of Instructional Computing. That is, during the course of instruction prospective teachers would be exposed to conditions of ambiguity, pluralism, third-wave information processing and reflective judgment. The goal of instruction would be to provide the conditions of learning necessary to promote higher levels of epistemological maturity and third-wave applications of instructional computing.

2. Based on the research done in the arena of developmental curriculum which has concluded that a ten-week course was often insufficient to affect much epistemological development (Perry, 1970; Knefelkamp, 1974; Widick, 1977), it is recommended that "epistemological" catalysts be systematically integrated into other key courses in the professional core. It would be appropriate to examine the possibility of affecting epistemological maturity through a "developmental" curriculum which networked key professional courses with strands of epistemological development. The goal of the curriculum would be to expose prospective teachers to those conditions which promote epistemological maturity. Following Perry's model, the freshmen and sophomore level courses would focus on conditions of ambiguity and

pluralism: the conditions which promote the progression from Dualism to Multiplicity (Perry, 1970). The junior and senior level courses would focus on developing a community of scholars: the condition which promotes the progression from Multiplicity to Relativism (Perry, 1970).

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APPENDICES

APPENDIX A

EDIM 251 FOUNDATIONS OF INSTRUCTIONAL COMPUTING
STUDENT ASSIGNMENT GUIDELINES
FOR
COMPUTER-BASED LESSON PLANNING TASK

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Text of File: Lesson Plan Project

The Lesson Plan Project is where the 'rubber meets the road' in EdIM 251. It is designed to be a synthesis of the skills and concepts that you have learned in this class into a practical application of the computer in education; specifically it is the design of a teaching lesson which involves the computer in some way. You will do the lesson project assignment concurrently with the lab assignments but will assemble the components into a project and turn it in at the end of the quarter rather than weekly. The project counts toward 30% of your final grade.

To complete this project you will complete several tasks or components as specified below and then put them together into a integrated lesson or activity. Basically the steps are: use databases to locate educational software and information; evaluate the software; design a lesson or activity that incorporates the software in some fashion; use the computer to produce support materials for the lesson; devise a method to evaluate the effectiveness of the lesson; and share and critique lessons with others. In order to keep the assignment consistent for everyone I have set a few common requirements. First, assume that you have been assigned to teach a class of 24 students (you pick the age group)

and have access to a lab of 12 micro computers with enough software for every machine. Second, your lesson must span four hours; this may be a one four-hour block or it may be spread over several days. The concept(s) that you choose to teach in your lesson are up to you but make sure that the software you use can be integrated in a practical way. Third, you must use the computer in some way; it does not have to be the main teaching activity, i.e. it may be used for enrichment or in some other indirect fashion. The students do not have to spend all four hours on the computer. Just make sure that all students have equal access to the computer during the course of the lesson. Fourth, all of the lesson's components must be integrated, i.e. each part fits well into the total teaching scheme.

I have specified below all of the components that must be included in the project. Please place these components in the project in the order assigned. Be sure to include a content outline and a timeline in your lesson plan. I will evaluate your project based on quality, creativity, and integration of the materials in the lesson.

1. Use a local database to locate educational software.

I have placed an updated file on the Syllabus disk which contains a database of information about the software currently available in our lab. This

database was created using AppleWorks and can be searched, arranged, and printed. You will search this database by age level and major and/or minor area to find software to use in your lesson project. Use the instruction and guidelines presented in lab to search this database. If you find that the software you initially locate is not acceptable for your lesson project, please re-search the database for a new title. Since our software library is in its infancy (but growing rapidly) we may not have exactly the type software that you would like to use. Please find something as close as possible to your teaching area and do the best you can with it. Once you have started your project you may NOT select another title. One trait of a good teacher is the ability to make do with the resources at hand - ingenuity. For the first component of your project use AppleWorks to list the title(s) on the screen from your search - then press Open-Apple-H to print out the screen. Label this as component 1 in your project.

2. Use national databases to find additional information out about the software you have selected.

After you have found a piece of software that is acceptable to you, I would like you to engage in three activities to find as much information out about your software and related software as possible.

- a. Using the Macintosh Plus Computer (AB), contact the AppleLink Information Service and search the "Apple/3rd Party Programs" database for information about your software. This national database contains information on over 10,000 software products available for Apple computers. Experience has shown that over 90% of our software is described in this database. Each entry is a description written by the vendor so obviously it will be biased. Using AppleLink costs use \$25/hour in the day and \$12.50/hr at night. Needless to say I would like you to do this at night! Complete instructions on how to use AppleLink will be available from the lab monitor. In addition I will demonstrate this procedure in class. Be sure to include a printout of this search as component 2a in your project.

- b. Go to the library and search the Infotrac database for an article in a periodical relative to your particular software OR one that describes how software is being used in your area of teaching. For example, if you are using an adventure game called "Moon Journey" and can't find an article about it by name, try other keywords such as computer, game, adventure, simulation, space, planets, astronomy, etc. to locate a related article. Be sure to make a print out of your Infotrac search and a photocopy of the article; then place this in your project as component 2b. The Infotrac computers are found in the reference section of the library.
- c. From the software catalogs made available to you in the lab or from other sources (computer store mail order catalogs, etc.) find information about OTHER CAI software packages that you might also be able to integrate in your lesson in addition to the software you have selected. Photocopy what you found and place it in your project as component 2c.

3. Evaluate your selected software.

Check out and become familiar with the software that you are going to use in your Lesson Plan Project.

Then print out the MicroSIFT evaluation/description form on the Syllabus disk and use it to extensively evaluate your software. Be as complete as possible and fill in EVERY component using a pen or pencil. Include this as component 3 in your project.

4. Write your lesson.

I have identified six things that I want you to include in your lesson. Read the file called Lesson.Plan on the Syllabus disk to find out exactly what you need to include. In my teaching duties I rarely write my lessons in the detail that I am asking you to write. However, the only way that I can truly evaluate what you have done is to have you describe your lesson NARRATIVELY which obviously includes more detail than a typical lesson plan would. To get a good idea of how detailed to make it assume that you are writing this lesson for a substitute teacher to teach. Include the finished lesson plan in your project as component 4.

Text of File: Lesson.Plan

Using the software that you have selected, design a lesson that is appropriate for the grade level and subject

area that you intend to teach. I realize that you may be restricted somewhat because of our limited software selection; however, this activity is designed to see if you can use existing software found in your school in a resourceful and educationally sound manner.

Your lesson must use the software and computer in some instructional way for a four hour period of instruction. Also, the students do not have to spend all of their time on the computer. You may wish to use the computer as an enrichment activity. The basic requirement is that your lesson includes the use of the computer in some way.

Please incorporate all the following into your lesson plan:

1. Resources Required - software, computer, workbooks, and any support materials.
2. Objectives of Lesson - These are what you intend to have your students learn from this lesson. I recommend that you state the objectives in this form: "After completion of this lesson students will be able to.."
3. Methodology - This is the lesson/activities that you are going to engage your students in. It should be general in nature but be sure to be specific enough so that a substitute teacher

could teach the lesson. Since the only way I can evaluate your lesson is to read it, please be as descriptive as possible. Be sure to include a content outline and a timeline. Your lesson should also refer to seven graded assignments or exams; you do not have to produce them, just description of them and how they are integrated into your lesson. (Note: since you have to make an exam - component 6 - use this as one of the seven.)

4. Management Strategy - Keeping in mind your student/computer ratio, explain how you are going to get all of your students equal time on the machines. Assume that you have one copy of your software for each machine. This is a very important part of the project - be sure to put some effort into different strategies for solving this common dilemma.
5. Lesson Evaluation - Describe how you are going to measure the effectiveness of your lesson. This may be a quiz, test, discussion, etc.
6. Be sure to include information concerning who you are teaching and what their grade level is.

Text of File: Lesson Plan Project, Continued

5. Produce support materials for your lesson.

Use each of the following programs and criteria to produce materials that support your lesson. Make sure that each of these is integrated, i.e. that they fit well into the lesson scheme.

- a. Crossword Puzzle or Word Search - Use the CrossWord Magic or Super Wordfind programs to make a puzzle or wordfind that includes at least 15 vocabulary words relative to your lesson. Your words should relate to the lesson and do not necessarily have to be taken from your software. Print this out including the clues and key. Include this in your project as component 5a.
- b. Overhead - Use FullPaint, DazzleDraw, the Print Shop, or some other Graphics Utility to produce an overhead transparency that relates to your lesson. Print out the master and label in your project as the overhead. You may, if you wish, photocopy your overhead master and take it to Media Services in Reid Hall to make the transparency. (cost is about 50 cents) Include this in your project as component 5b.

- c. Handout - Use the computer and any software to make a handout for your lesson. Be sure to integrate it into your lesson. Include this in your project as component 5c.

You may also include any other materials that you have time to produce and feel that you need to complete the lesson.

6. Produce a summative evaluation.

Tests are not always the best method of evaluating the effectiveness of a lesson, although they are probably the most common. However, for this exercise, use the Testmaker program to construct a complete test or quiz for your lesson. You may also wish to describe alternate methods of evaluating the effectiveness of your lesson. Include this in your project as component 6.

7. Keep student records.

The computer is best at doing routine and repetitive tasks we humans think are mundane. One good example is grade keeping. Add the file called UsingGradeSheet to the AppleWorks desktop and follow its instructions to enter your fictitious student names and other class data into the file called GradeSheet.2. Both files are found on your Syllabus disk. Be sure to fill out the entire gradesheet

including instructor, letter grades and the assignment key. Notice that there is room for seven assignments; simply make up grades from fictitious but plausible assignments. Then, calculate the spreadsheet, save it, and print it out. Include this in your project as component 7.

8. Peer critique.

One of the most beneficial activities that teachers can engage in is sharing. This tends to better the teaching act and to develop comradery among educators. Before you finalize your lesson I would like you to share your lesson with at least two people and have them fill out the peer critique form. First, go to the lab and show these people your software. Then, show them your lesson project and describe what you are going to do. Finally, have them write their comments on the peer critique form which you have printed out for them as follows: add the file called Peer.Critique from the Syllabus disk to the desktop and print out a copy for each of those who are going to critique your lesson. Use these critiques to improve and/or modify your lesson. Include these two critiques in your project as component 8.

9. Finalize and assemble your lesson.

Make any last minute changes to your lesson, put it all together and turn it in by the specified due date. TURN IN TWO COPIES.

PERMISSION TO USE COPYRIGHTED MATERIAL

I, Randy Knuth, owner of the copyright to the works known as Lesson Plan Project and Lesson.Plan hereby authorize Christine H. Lamb to use the following text as part of her doctoral dissertation to be submitted to Montana State University:

Text of AppleWorks file: Lesson Plan Project

Text of AppleWorks file: Lesson.Plan

APPENDIX B

EDIM 251 FOUNDATIONS OF INSTRUCTIONAL COMPUTING
COMPUTER-BASED LESSON PLANNING TASK:
RATING GUIDELINES
AND
SAMPLE SCORE SHEET

Rating Strategies

Assemble the following components of the computer-based lesson planning project:

1. completed Microsoft Evaluation Form for the software used;
2. lesson plan description;

Read each component and decide whether the second-wave or third-wave approach is predominant in the lesson by matching the lesson to the characteristics of each type.

Second-wave approach:

General characteristics

1. lesson focuses on traditional methodologies;
 - a. drill and practice
 - b. rote learning
2. computer itself is the focus of the lesson;
3. computer work is complement to instruction;
 - a. extra practice
 - b. entertainment
 - c. reward for finishing other work

Student role in learning:

1. objectives focus on lower level objectives
 - a. knowledge
 - b. comprehension
 - c. application
2. learner is passive receiver of instruction

Teacher role in learning:

1. teacher is primary source of information
2. computer is distinctly separate from rest of instruction

Third-wave approach:**General characteristics**

1. lesson focuses on ways to teach differently with technology;
2. computer itself is not the focus of the lesson;
3. computer work is integrated into instruction;

Student role:

1. objectives focus on higher levels of learning
 - a. analysis
 - b. synthesis
 - c. evaluation
2. learner focuses on interactive learning with the computer

Teacher role in learning:

1. teacher explores new methods/applications using technology
2. computer work is integrated into instruction.

Subsequent to identifying the general approach of the lesson, use the following guidelines to identify the level of integration of computer technology into instruction.

Level One: Second-Wave/Low Integration

Computer is treated as extraneous to instruction

1. reward for finishing other work
2. entertainment

Level Two: Second-Wave/High Integration

Computer is treated as a supplement to instruction

1. extra problems/practice
2. drills

Level Three: Third-wave/Low Integration

Learning objectives focus on higher level learning but computer is still treated as a supplement to instruction

Level Four: Third-wave/High Integration

Learning objectives focus on higher level learning and computer is integrated into instruction

Using the score sheet, circle the appropriate type and level of integration. Write appropriate holistic score in the space provided.

SAMPLE SCORE SHEET

PRJ#: _____

RATER: R C

Objectives: Student role in learning

2nd 3rd UR

Management: Teacher role in learning

2nd 3rd UR

Methodology: Focus on computer

2nd 3rd UR

Level of overall Integration:

L H UR

Type of overall Integration:

2nd 3rd UR

Score: _____

- 1 = 2nd-wave/low integration
- 2 = 2nd-wave/high integration
- 3 = 3rd-wave/low integration
- 4 = 3rd-wave/high integration
- UR = unrateable

APPENDIX C

SUPPLEMENTARY DATA TABLES

Table 15. Population Distribution: Gender.

Gender	Total	Percent
M	400	36.17%
F	706	63.83%
	-----	-----
	1106	100.00%

Data were supplied to the researcher by the Montana State University Registrar's Office. Data reflect the gender distribution of Montana State University students coded into one of the teacher preparation or certification programs Autumn quarter, 1987.

Table 16. Population Distribution: Class by Option.

Option	Class					Tot
	Fr	So	Jr	Sr	Gr	
AG	14	7	8	16	0	45
IA	4	10	15	30	1	60
ELED	111	84	71	119	9	394
PE	25	26	33	37	1	122
HEC	3	8	6	17	1	35
SCED	13	18	20	38	9	98
BIO TEACH	2	2	5	13	2	24
CHEM TEACH	0	1	1	3	0	5
ENGL TEACH	12	16	22	33	5	88
HIST TEACH	7	7	8	10	0	32
MATH TEACH	5	16	22	40	3	86
LANG TEACH	2	2	4	3	1	12
SCI TEACH	0	0	1	2	0	3
ART ED	5	1	2	14	3	25
MUS ED	26	12	10	23	3	74
BUED	0	3	2	6	0	11
BUOS	1	3	3	8	1	16
TCERT	0	0	0	0	70	70
	-----	-----	-----	-----	-----	-----
	230	216	233	412	109	1200
	19.20%	18.00%	19.40%	34.30%	9.10%	

Data were derived from the Montana State University Registrar's Office "Report G", dated October 16, 1987. The data reflect the number of students enrolled in each option of interest during Autumn quarter, 1987. Discrepancies between population totals reported in the gender distribution and in the class distribution were attributed to fluctuations in student enrollment.

Table 17. Population Mean Age.

Variable	N	Min.	Max.	Mean	Std. Dev.
AGE	1060	17	58	24.53	6.4182

Data were supplied by the Montana State University Registrar's Office. The data reflect the mean age of students enrolled in one of the teacher preparation or certification options during Autumn quarter, 1987. Discrepancies between population totals reported in the gender distribution, class distribution, and age distribution were attributed to fluctuations in student enrollment.

Table 18. Summary Data: Inter-rater Reliability.

Scores & Squared Scores											
Rater	Protocol										TOT
	A	B	C	D	E	F	G	H	I	J	
1	4	2	1	1	3	2	4	3	1	1	22
2	3	1	1	1	3	2	3	4	1	1	20
	7	3	2	2	6	4	7	7	2	2	42
	49	9	4	4	36	16	49	49	4	4	

20 protocol scores squared = 114
 10 protocol totals squared = 224
 2 rater totals squared = 884

Variances and Reliability Coefficient

Total score = 4.76 r = .92
 Sum of Item = 2.56

Table 19. ANOVA: CAS by EXP.

Source of Variation	Sum of Squares	DF	Mean Square	F	P-Value
Between Groups	2.9411	5	.5882	3.8715	.0022*
Within Groups	31.2987	209	.1519		
Total	34.2398	211			

* Significant at the .05 level.

Table 20. Summary Data: Scheffe Multiple Comparison.

Mean	Group	G	G	G	G	G	G
		r	r	r	r	r	r
		P	P	P	P	P	P
		3	1	5	2	4	6
3.07	Grp 3						
3.09	Grp 1						
3.26	Grp 5						
3.29	Grp 2						
3.32	Grp 4						
3.39	Grp 6		*				

* Denotes pairs of groups significantly different at the .05 level.

Note: SPSSX reported multiple comparisons graphically as depicted above. Values of F and F' were not reported.

Table 21. Frequency Distribution: CAS by MF and EXP.

Gender	Levels of Prior Computer Experience					
	1	2	3	4	5	6
M	14	5	5	14	13	15
F	38	19	12	26	21	30

Table 22. Frequency Distribution: CAS by Project.

Project	Levels of Computer Anxiety			
	1.00-1.99	2.00-2.99	3.00-3.99	4.00-4.99
1	0	24	59	0
2	0	29	63	1
3	0	9	29	0
4	0	5	2	0

Table 23. Frequency Distribution: MER by AGE and Gender.

Gender	Age	
	Trad	NTrad
M	28	38
F	83	63

Table 24. Frequency Distribution: MER by Project.

Project	Levels of Epistemological Maturity				
	1.00- 1.99	2.00- 2.99	3.00- 3.99	4.00- 4.99	5.00- 5.99
1	1	53	26	3	0
2	0	40	46	7	0
3	0	3	10	15	1
4	0	0	4	3	0

Table 25. ANOVA: Stepwise Regression Model.

Step 1 MER Entered					
Source of Variation	DF	Sum of Squares	Mean Square	F	p-Value
Regression	1	38.99965	38.99965	87.6367	.0000
Residual	210	93.45318	.44502		
R2 = .29444		Adjusted R2 = .29108		SE = .66709	
Variable in Equation	b	SE b	T	Prob>T	
MER	.654640	.069929	9.361	.0000	
Constant	-.153651	.214843	-0.715	.4753	

Step 2 AGE Entered					
Source of Variation	DF	Sum of Squares	Mean Square	F	p-Value
Regression	2	43.63537	21.81768	51.34008	.0000
Residual	209	88.81746	.42496		
R2 = .32944		Adjusted R2 = .32302		SE = .65189	
Variables in Equation	b	SE b	T	Prob>T	
MER	.604890	.069976	8.644	.0000	
AGE	.025034	.007580	3.303	.0011	
Constant	-.624273	.253735	-2.460	.0147	

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