

A THEORY OF EFFECTIVE COMPUTER-BASED INSTRUCTION
FOR ADULTS

A Dissertation

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by

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DEDICATION

This dissertation is dedicated to the memory of my mother, Johnnye Ann Lowe, who always believed in me. Mother had a strong work ethic and went back to school at age 45 to obtain her LPN degree. The values I gained from her and her encouragement and faith in me throughout my life has enabled me to obtain this goal.

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ABSTRACT

Computer-based instruction (CBI) was considered the technological phenomenon to revolutionize education and training. Today, the Internet and computer technology are reported to have significantly altered the education landscape (Johnson & Aragon, 2002). The rapid advances in technology, the need for lifelong learning, and the growth of non-traditional students have encouraged the use of the computer as a method of instructional delivery. Evaluating the effectiveness of CBI as a whole technology is very difficult. The inability to measure effectiveness is attributable in part to the fact that CBI is not just one component, but a complex range of services and activities carried out for instructional and learning purposes (Gibbons & Fairweather, 2000).

This study presents a theory of critical components that impact the effectiveness of computer-based instruction for adults. The theory was developed to provide a framework for research to explain or predict effective learning by adults using a desktop computer. The five conclusions drawn from this research are: (1) the characteristics of self-directedness and computer self-efficacy of adult learners play an important role in designing CBI for adults; (2) learning goal level impacts instructional design strategy and instructional control component of CBI design; (3) external support and instructional support are needed to provide a positive CBI experience; (4) CBI design is interwoven with the units of self-directedness, computer self-efficacy, learning goal level, instructional design, and external support; and (5) the theory draws together the isolated variables researchers consider important in the adult learning process and aligns them to provide effective CBI.

CHAPTER 1 INTRODUCTION

In a knowledge-based economy, educating the workforce tops the agenda of many business and government leaders. Training is considered by many to be one key to American competitiveness and worker success in the global economy. Much of corporate America's interest in learning stems from a lack of skilled workers. The skills gap is one result of the unprecedented rate of change in technologies and business processes that affect all workers.

As early as the 1980's, computer-based instruction (CBI) was considered the technological phenomenon to revolutionize education and training. Kemske reported in "The Computer-Based Training Report" (Filipczak, 1997) that computer-based training jumped to 15 percent of all training conducted by respondents in his study, up from ten percent the previous two years (1995 & 1996). Thirty-nine (39) percent of the respondents reported that the corporation's intranet was going to be a means of delivering training in 1997. Training magazine's "Industry Report 1999" reported that an estimate of 19 percent of all formal training was delivered via computer in 1998 and declined to 14 percent in 1999. Industry estimates predict that by 2003, no less than 30 percent of all training will be delivered over corporate intranets (Ryan, 2001).

Today, the Internet and computer technology are reported to have significantly altered the education landscape (Johnson & Aragon, 2002). With the advances of the technology and software surrounding the Internet, the conversion of courses from traditional face-to-face instruction into Web-based courses has become easier and is occurring more systematically in education (Jiang & Ting, 1998). However, Phipps & Merisotis (1999) concluded that there is

a lack of evidence that technology influences the learning process and that course design and pedagogy are important factors. There are those who believe that the theories and principles that guide practice in traditional face-to-face instruction can not be directly converted to computer-based instruction (Williams, 2000). There are also those who concluded that a single learning theory is not enough, but that a quality learning environment should be based on instructional principles that are derived from multiple learning theories (Johnson and Aragon, 2002). However, there must be attempts at theoretical explanations for learning professionals to make teaching and learning decisions with confidence using this technology.

Rationale for Study

The rapid advances in technology, the need for lifelong learning, and the growth of non-traditional students have encouraged the use of the computer as a means of instructional delivery. Some of the advantages for using the computer as a method of instructional delivery are that it: provides consistency of content delivery; provides training to remote locations; eliminates cost associated with employees' travel; provides means of tracking learner's progress; provides standardized testing; offers learner flexibility in controlling and pacing learning; provides for diverse learning needs; provides opportunities for practice through simulation; provides greater retention; and reduces the instructional time by approximately 30 percent. Two conclusions drawn from meta-studies on CBI are: (1) learners generally learn more using CBI than they do with conventional ways of teaching as measured by higher post-treatment test scores (Fletcher, 1999; Kulik, 1994), and (2) learners using CBI generally do so in less time than those using traditional approaches (Kulik & Kulik, 1991; Orlansky & String, 1979). When you look at all the advantages of computer-

based instruction, the question is why aren't more companies using this as their major delivery method?

In their "Industry Report 2000", Training magazine reported 13 percent of all courses are delivered via computer-based training with no instructor. That is a decrease from statistics reported in 1999 and less than half of what was predicted by others in the training field. The predictions for computer-based training have not been met. Are the advantages of computer-based training understood by the learning professionals? If so, why aren't they adopting more of this type of instructional delivery?

Technology has quickly outpaced the theory that supports its effectiveness, and the application of technology has surpassed the evaluation of that technology. There is no body of research that meaningfully unites training objectives, training content, instructional style, and distance learning media (Wisher & Champagne, 2000). Crawford and Suchan (1996) drew a similar conclusion in their call for systematic selection of "instructional media for specific learning applications that place priority on the desired learning outcome and the media required to support the instructional techniques to attain that outcome"(p. 36).

In addition, evaluating the effectiveness of CBI as a whole technology is very difficult. The inability to measure effectiveness is attributable, in part, to the fact that CBI is not just one component, but a complex range of services and activities carried out for instructional and learning purposes (Gibbons & Fairweather, 2000).

In the initial review of literature on computer-based learning and adults, there were a number of constructs that were found to be included in research studies:

- adult learner (Barrett, 1991; Bates, Holton, & Seyler, 1996; Brown, 2000; Brown, 2001; Courtney, Vasa, & Luo, 1999)
- attitudes toward computers (Brock & Sulsky, 1994; Chau, 2001; Jawahar & Elango, 2001; Suriya & Wentling, 1999)
- computer anxiety (Ayersman & Reed, 1995-96; Elder, Gardner, & Ruth, 1987; Harrington, McElroy, & Morrow, 1990; Howard, Murphy, & Thomas, 1987; Marcoulides, 1988)
- computer efficacy (Hill, Smith, & Mann, 1987; Massoud, 1991)
- learning environment (Choi & Hannafin, 1995)
- gender (Busch, 1995; Lewis, 1988)
- learning theories (Chalmers, 2000; Johnson & Aragon, 2002; Tennyson, 1990; Williams, 2000)
- learning characteristics or individual differences (Armstrong, 1996; Buehner-Brent, 1990; Harp, Taylor, & Satzinger, 1998; Igbaria & Parasuraman, 1989)
- learning styles (Bostrom, Olfman, & Sein, 1990; Brudenell & Carpenter, 1990)
- learner needs (Wiswell & Ward, 1997)
- locus of control (Avner, Moore, & Smith, 1980; Hannafin, 1984; Shaw, 1992)
- performance, measurement or evaluation (Bowman, Grupe, & Simkin, 1995; Bratton-Jeffery, 1997; McInerney, Marsh, & McInerney, 1998)
- self-directed learning (Barrett, 1991; Confessore & Kops, 1998; Mills & Dejoy, 1988)

- self-efficacy (Christoph, Schoenfeld, & Tansky, 1998; Gist, Schwoerer, & Rosen, 1989).

This is not to say that these research articles only included one specific construct. In most cases, each article contained a minimum of two constructs and one article contained as many as eight constructs. For example, the research article by Brown (2001) included adult learner, goal orientation, learning self-efficacy, individual differences, behavioral and cognitive learning, locus of control, computer-based learning environments, and computer experience. Brown (2001) concluded that there exists considerable variability in learners and learner choices and this will be increasingly important as a determinant of overall training effectiveness. The researcher-theorist initially tried to determine a quantitative study that would further the knowledge of learning using computer-based instruction, recognizing the various constructs that had been included in research on computer-based instruction. A recent empirical study performed by Jones and Paolucci (1999) estimates that since 1993, less than five percent of published research was sufficiently empirical, quantitative, and valid to support conclusions with respect to the effectiveness of technology in education learning outcomes. Thus, there was a lack of evidence on what really impacts learning using the computer as a medium for delivery of instruction.

Despite the abundance of research studies exploring a limited number of constructs in CBI, there have been only modest attempts at building a theoretical base for CBI. Williams (2000) found in her research on a framework for online environments for learning that there are several different views of what learning theory best fits learning by means of the computer. Because of these differences, it reiterated the need for theoretical approaches to

learning. The behaviorist wants the learner to produce desired behaviors by controlling the environment while the constructivist wants to see how learning occurs. Williams (2000) found that an integration of behaviorist principles and constructivist principles may be best suited for computer-based instruction.

Johnson and Aragon (2002) have begun developing a framework for instructional strategies for use in the computer learning environment. They also found a lack of evidence that technology significantly influences the learning process. Johnson and Aragon (2002) hypothesized that quality learning environments should be based on instructional principles that are derived from multiple learning theories. The challenge is to devise ways to create pedagogically sound content for delivery by the computer. The information to be learned needs to address variability in learning styles, provide motivation, and promote interactivity. Johnson and Aragon (2002) suggest that the learning environment should be comprised of the elements in behavioral, cognitive, and social learning theory.

Steinberg (1991) also concludes that behavioral and cognitive learning theories should be integrated. CBI draws on learning theories, instructional models, practical experience, and technology. She synthesized theories of Bransford (1979) and Gagné (1977) and developed a framework for CBI that includes four components from learning theories and instructional models: target population, goals, task, and instruction; and two components from research and experience: computer application and environmental implementation.

Kember and Murphy (1990) report that instructional design based on behavioral learning theory has been limiting and that new theories should be consistent with constructivist theories of cognitive psychology and allow for flexible, pragmatic development

approaches. Kember and Murphy believe that “technologies should teach learner to learn rather than act as passive purveyors of information or techniques for reducing learner involvement in the learning process. If teaching is the facilitation of learning, then efforts need to be concentrated on the learner rather than the instruction” (p. 45).

These studies by Williams (2000), Johnson and Aragon (2002), Steinberg (1991), and Kember and Murphy (1990) report that adopting a synthesized theory of learning can have a synergistic result in developing individual learning theories into the learning environment of computer-based instruction. Based on these studies, it is becoming apparent that others besides the researcher-theorist believe that there is a need for an integration of theories and the development of a framework which can be empirically tested to provide the appropriate learning environment for computer-based instruction.

Computer-based instruction can provide an effective and efficient device for implementing training to improve workplace performance. Educators of the adult populations in business and industry and learning professionals need to develop expertise as facilitators of computer-based learning and critical evaluators of technology. A theory of effective computer-based instruction for adults would aid them in this endeavor. A computer-based instruction solution must match the level of workplace performance desired, provide gains over instructor-led training, and suit a corporate training culture (Passmore & McClernon, 1996). Adult professionals who are evaluated on the basis of job performance and who need to learn while they work must have different instructional programs from the typical school instruction for which the objective is subject matter mastery and the evaluation is based on a test score. Burge and Roberts (1993) reported that technology in and of itself,

does not promote learning. Part of using technology effectively is understanding what adults want in the learning environment when technology is employed.

The advent of the Internet has changed how people will communicate and train in the twenty-first century. Technology will continue to create new and more powerful learning environments. Will the learning professional be able to take advantage of the technology? With a theory of effective computer-based instruction for adults, there will be a theory to drive research that will provide guidelines for practice. Research without theory is not as effective.

Problem Statement

Technology has quickly outpaced the theory that supports its effectiveness, and the application of technology has surpassed the evaluation of that technology. There is no body of research that meaningfully unites training objectives, training content, instructional style, and distance learning media (Wisher & Champagne, 2000). Based on research conducted for the study, there are many constructs that need to be considered in using a desktop computer as a means of delivering instruction or training. However, there is no theory that integrates the critical components of computer-based instruction that would provide a model for more effective training.

Purpose of Study

The purpose of this study is to provide a theory of critical components that impact the effectiveness of computer-based instruction for adults. This study will develop a theory that integrates existing research to explain or predict effective learning by adults using a desktop computer as the medium. The continued growth of Human Resource Development (HRD) as

a profession will be facilitated by the development of a theory of effective computer-based instruction for adults based on research.

Objectives

The objectives of this study will be to answer the following questions:

1. What are the units or variables of a theory of effective computer-based instruction for adults?
2. What are the laws of interaction of a theory of effective computer-based instruction for adults?
3. What are the boundaries of a theory of effective computer-based instruction for adults?
4. What are the system states of a theory of effective computer-based instruction for adults?
5. What are the propositions of a theory of effective computer-based instruction for adults?

Limitations of the Research

Potential limitation of the research is in the availability and knowledge of all the relevant studies on computer-based instruction for adults. Although an attempt will be made to locate all relevant studies, it is likely that some pertinent studies will not be included. Several articles in foreign publications are not available to the researcher. As research articles are identified, every effort will be made to obtain the research article for inclusion in this study. Another limitation will be the biases of the researcher-theorist. The researcher-theorist's own logic and objectivity cannot help but influence the outcome of this study. A

third limitation is that in modeling reality some aspects may be excluded. The researcher-theorist will strive for a comprehensive theory that is also parsimonious.

Significance of the Study

A theory of effective computer-based instruction for adults has the potential for making significant contributions to influence and guide scholars and learning professional in Human Resource Development (HRD). Theory is dynamic. It is constantly evolving, and as organizations change in response to external environments, theories on which we build the HRD disciplines need to keep pace. As the field of HRD continues to grow and mature, as technology changes, and as knowledge-based organizations become of greater importance in the global economy, a theory of effective computer-based instruction for adults will have major impact on the delivery of training in organizations.

CHAPTER 2

REVIEW OF LITERATURE

The literature necessary for developing a theory of effective computer-based instruction for adults is diverse. This chapter is subdivided into eight parts: multiparadigms, theory building, evaluating theory, the role of theory building in human resource development (HRD), general learning theories, andragogy, computer-based instruction theory building, and research of computer-based instruction (CBI). The first four sections will provide information on theory: multiparadigm perspectives of theory building, Dubin's theory building inquiry method, Patterson's criteria for evaluating theory, and the role of theory in the human resource development. The fifth and sixth sections will provide a review of the literature concerning learning theories and andragogy. The seventh and eighth sections will review some of the literature on CBI theory building and research of CBI. This summary of theory literature provides a conceptual foundation for the development of a theoretical framework for a theory of effective computer-based instruction for adults.

Multiparadigm Perspectives of Theory Building

Theory building discussions seem to proceed as if the principles of theory building are somehow universal and transcendent across disparate paradigms of thought and research (Gioia & Pitre, 1990). Because different paradigms are grounded in fundamentally different assumptions, they produce markedly different ways of approaching the building of theory. A paradigm is a general perspective or way of thinking that reflects fundamental beliefs and assumptions about the nature of phenomena (Kuhn, 1970; Lincoln, 1985). Differing

fundamental assumptions about the nature of the phenomena (ontology), the nature of the knowledge about those phenomena (epistemology),

Table 1: Paradigm Differences Affecting Theory Building

Interpretivist Paradigm	Radical Humanist Paradigm	Radical Structuralist Paradigm	Functionalist Paradigm
Goals To DESCRIBE and EXPLAIN in order to DIAGNOSE and UNDERSTAND	Goals To DESCRIBE and CRITIQUE in order to CHANGE (achieve freedom through revision of consciousness)	Goals To IDENTIFY sources of domination and PERSUADE in order to GUIDE revolutionary practices (achieve freedom through revision of structures)	Goals To SEARCH for regularities and TEST in order to PREDICT and CONTROL
Theoretical Concerns <ul style="list-style-type: none"> • SOCIAL CONSTRUCTION OF REALITY • REIFICATION PROCESS • INTERPRETATION 	Theoretical Concerns <ul style="list-style-type: none"> • SOCIAL CONSTRUCTION OF REALITY • DISTORTION • INTERESTS SERVED 	Theoretical Concerns <ul style="list-style-type: none"> • DOMINATION • ALIENATION • MACRO FORCES • EMANCIPATION 	Theoretical Concerns <ul style="list-style-type: none"> • RELATIONSHIPS • CAUSATION • GENERALIZATION
Theory Building Approaches DISCOVERY through CODE ANALYSIS	Theory Building Approaches DISCLOSURE through CRITICAL ANALYSIS	Theory Building Approaches LIBERATION through STRUCTURAL ANALYSIS	Theory Building Approaches REFINEMENT through CAUSAL ANALYSIS

Source: Gioia, D. A. & Pitre, E. (1990)

and the nature of ways of studying those phenomena (methodology) fuel the debate over different philosophical views and conceptual paradigms (Burrell & Morgan, 1979; Lincoln, 1985). Burrell and Morgan (1979) have organized these differences along objective-subjective and regulation-radical change dimensions, yielding four different research paradigms for analysis of social theory: (1) interpretivist, (2) radical humanist, (3) radical structuralist, and (4) functionalist. In their pure form, these paradigms cannot be synthesized because they are contradictory. The four paradigms are mutually exclusive and one can not operate in more than

one paradigm at any given point in time, since accepting the assumptions of one, is defying the assumptions of all the others (Burrell & Morgan, 1979). Table 1 summarizes these paradigm differences affecting theory building.

Interpretivist Paradigm

The interpretive paradigm is characterized by a more subjectivist view with an apparent concern with regulation or a lack of concern with changing the status quo. The interpretive paradigm is based on the views that people socially and symbolically construct and sustain their own organizational realities (Berger & Luckmann, 1966; Morgan & Smircich, 1980). The goal of theory building in the interpretive paradigm is to generate descriptions, insights, and explanations of events so that the system of interpretations and meaning and the structuring and organizing processes are revealed (Gioia & Pitre, 1990). Interpretive theory building tends to be more inductive in nature. Researchers attempt to account for phenomena with as few a priori ideas as possible and strong precautions are taken to prevent emerging theories from being biased toward or contaminated by existing theories. The interpretive researcher collects data that are relevant to the informants and attempts to preserve their unique representations. Analysis begins during data collection and typically uses coding procedures to discern patterns in the qualitative data so that descriptive codes, categories, taxonomies, or interpretive schemes that are adequate at the level of meaning of the informants can be established. The theory generation process is typically iterative, cyclical, and nonlinear. Revisions and modifications are likely to occur before a grounded, substantive, mid-range theory is proposed (Eisenhardt, 1989; Yin, 1984).

Radical Humanist Paradigm

The radical humanist paradigm is also typified by a subjectivist view but with an ideological orientation toward radically changing constructed realities (Gioia & Pitre, 1990).

The goal of theory in this paradigm is to free organization members from sources of domination, alienation, exploitation, and repression by critiquing the existing social structure with the intent of changing it. Theory building is best viewed as having a political agenda (Rosen, 1985) to examine the legitimacy of the social consensus on meaning, to uncover communicative distortions, and to educate individuals about the ways in which distortions occur (Forester, 1983; Sartre, 1943 cited in Gioia & Pitre, 1990). Radical humanists focus on why a particular social reality is so constructed and ask whose interests are served by the construction and sublimation to the deep-structure level. Hypothesis testing is rare and literature reviews are not a central characteristic of theory building efforts. The theory building process is limited to reinterpretations of existing deep-structure accounts. Theories in this paradigm are intended to serve as motivating impetus for change toward an ideologically laden viewpoint.

Radical Structuralist Paradigm

The radical structuralist paradigm is typified by an objectivist stance with an ideological concern for the radical change or transformation. Societal and organizational functioning is seen as constrained by social forces stemming from existing dysfunctional structural relationships, which can only be changed through some form of conflict (Gioia & Pitre, 1990). The goal of radical structuralist theory is to understand, explain, criticize, and act on the structural mechanisms that exist in the organizational world, with the ultimate goal of transforming them

through collective resistance and radical change (Heydebrand, 1983). Theory building involves the rethinking of data in light of refinements of viewpoints; it also involves attempting to recast contextually bound situations into some broader context (Benson, 1977). Theory building efforts are mainly persuasive constructions about structural features and their implications for the purpose of fomenting transformative change (Gioia & Pitre, 1990).

Functionalist Paradigm

The functionalist paradigm is characterized by an objectivist view with an orientation toward stability or maintenance of the status quo. The functionalist seeks to examine regularities and relationships that lead to generalizations and universal principles. Theory building typically takes place in a deductive manner, starting with the review of the literature and operating out of prior theories. Selecting specific variables as likely causes of some designated effect derives hypotheses. These hypotheses are tentative statements of relationships that extend prior theory in a new direction, propose an explanation for a perceived gap in existing knowledge, or set up a test of competing possible explanations for structural relationships. Variables, categories, and hypotheses all tend to remain constant over the course of the theory elaboration processes. The result of these processes is either the verification or falsification of the hypotheses, with theory building occurring through the incremental revision or extension of the original theory.

Paradigm Used in This Study

Theory building and contributions to theory have been driven mainly by social science variations of natural science models, which have been confined within the bounds of the functionalist paradigm (Gioia & Pitre, 1990). The assumption that the nature of phenomena is

a basically objective one, awaiting impartial exploration and discovery, have lead to a deductive approach to theory building specifying hypotheses deemed appropriate for the organizational world and testing them against hypothesis-driven data via statistical analyses.

The functionalist paradigm was used by Dubin to develop his applied theory building research method. Dubin (1976) tries to make sense out of the observable world by ordering the relationships among elements that constitute the theorist's focus of attention in the real world. The variables or units identified by the theorist, along with their interaction of these variables, the development of hypotheses to test, and the refinement of the theory are all part of the functionalist paradigm.

The functionalist paradigm was used as the basis for this study. The goal of this theory building research is to develop a theory that will predict an effective outcome for CBI. Using the steps of theory building from the functionalist paradigm, a theoretical framework will be developed from the critical components or variables identified in the literature review. Relationships of the critical components will be identified through the laws of interaction, which relate to the theoretical concerns of the functionalist paradigm. The propositions will be formulated from which hypotheses can be developed to test the theory, which is in the analysis step of the functionalist paradigm for theory building. The refinement and continued analysis of the theory are the last steps of Dubin's applied theory building methodology and will not be a part of this study.

Theory and Theory Building

The need for theories lies in human behavior or the need to impose order on

unordered experiences (Dubin, 1978). A theory is a system for explaining a set of phenomena that specifies the key concepts that are operative in the phenomena and the laws that relate the concepts to each other (Torraco, 1994). Dubin (1976) defines theory as an attempt of man to model some aspect of the empirical world. The underlying motive for this modeling is (1) that the real world is so complex it needs to be conceptually simplified in order to understand it, or (2) that observation by itself does not reveal ordered relationships among empirically detected entities. A theory, therefore, tries to make sense out of the observable world by ordering the relationships among elements that constitute the theorist's focus of attention in the real world (Dubin, 1976).

Dubin (1976, 1978), a distinguished scholar of theory and its origins, developed a widely used methodology for theory building, which describes the components of the theory building process. Dubin begins the theory building model with "units" whose interactions constitute the subject matter of attention to be addressed by the theory. The units of the theory and the laws by which the units interact constitute the major contribution to knowledge generated by a theory. Dubin's methodology for theory building consist of eight elements: (1) units whose interactions constitute the subject matter of attention, (2) the laws of interaction among the units, (3) the boundaries within which the theory is expected to hold, (4) the system states in each of which the units interact differently with each other, (5) the propositions of the theory, (6) empirical indicators, (7) the hypotheses derived from the theory, and (8) empirical research to test the theory. Dubin divides the theory building

research model into two parts: theory development (steps 1-4) and research operation (steps 5-8).

The first step of the applied theory building method requires identification of the units of the theory. The units represent the properties of things rather than the things themselves (Dubin, 1978). The units also represent those things whose interactions constitute the subject matter or the phenomenon that the theory is all about. The units of a theory are sometimes described as the concepts of the theory, or the basic ideas that make up the theory (Cohen, 1991; Dubin, 1978; Reynolds, 1971; Lynham, 2002). The units represent the things about which the researcher is trying to make sense and are informed by literature and experience. By translating these concepts to units, the researcher is able to identify the things or variables whose interactions make up the subject matter of attention (Dubin, 1978; Lynham, 2002).

The kinds of units used in the theory are determined by the choices made by the researcher regarding the unit types and the dichotomous characteristics. Dubin (1978, p. 58) identifies five types of units:

1. Enumerative unit is a property characteristic of a thing in all conditions. It must not have a zero value or an absent condition.
2. Associative unit is a property characteristic of a thing in only some of its conditions. It has a real zero or absent value.
3. Relational unit is a property characteristic of a thing that can be determined only by the relations among properties. The relationships may be interaction among properties or combination of properties.

4. Statistical unit is a property of a thing that summarizes the distribution of that property in the thing. Generally, statistical units summarize a central tendency in the distribution of a property, summarize the dispersion of a property, and locate things by their relative position in a distribution of a property.
5. Summative unit is a global unit that stands for an entire complex thing.

Summative units should not be used in theory development.

Dubin (1978) also identified five dichotomies of characteristics: unit versus event, attribute versus variable, real versus nominal, primitive versus sophisticated, and collective versus member. In distinguishing between a unit versus an event, an event happens only once while a unit must ultimately be able to count two or more entries. The reason for distinguishing between a unit and event is to distinguish certain types of historical explanation from theory and to dispose of the nagging problem of the uniqueness of all things at each point in time.

Distinguishing between attributes or variables is exceedingly important for the structure of tests used when a theory is confronted with empirical data. An attribute is a property that is always present while a variable is a property of a thing that may be present in degrees.

The distinction between a real and a nominal unit rests solely upon the probability of finding an empirical indicator for the unit. This means that every nominal unit has the potentiality of being converted into a real unit with progress in the technologies of developing empirical indicators. The issue is not to insist that theories contain only real units but that the

structure of the theory is clearly understood so that the functions of nominal units in them will be readily recognized.

Dubin considers primitive units as those that are undefined while sophisticated units are those that are defined. Primitive units are used when an unknown x is put into a theory and the theorist spends time trying to discover this x . This x will be turned into a sophisticated unit when discovered. The employment of primitive units in building a new theory occurs in one of the generalizing stages.

The last dichotomy that Dubin suggests one considers is collective versus member. This is the difference between a class considered as a unit and the individual member of that class being treated as a unit. The purpose of making this distinction is to designate many things sharing at least one common characteristic and to be able to treat them as a unit in a theory. In other circumstances one may want to treat one or more of the individual things as an independent unit because it shares membership in some collective unity by virtue of having at least one characteristic in common with all other members.

The kinds of units used in a theory are important as they can affect the theory's structure, the kinds of explanations and predictions the theory can generate, and the extensiveness of the tests that can be made of the theory (Dubin, 1978; Lynham, 2002).

A further and important requirement for identifying units of theory is to consider the outcome of developing the units of the theory against five criteria: rigor and exactness, parsimony, completeness, logical consistency, and the degree of conformity to the limitations on employment and combination of units (Lynham, 2002).

There are three limiting rules regarding the combination of types of units in a theory:

1. “A relational unit is not combined in the same theory with enumerative or associate units that are themselves properties of the relational unit” (Dubin, 1978, p. 73).

2. “Where a statistical unit is employed, it is by definition a property of a collective.

In the same theory do not combine such a statistical unit with any kind of unit (enumerative, associative, or relational) describing a property of members of the same collective” (p. 73-74).

3. “Summative units have utility in education and communication with those who are naive in a field. Summative units are not employed in scientific models” (p. 78).

The units enable the researcher-theorist to answer the first objective of the study: What are the units of a theory of effective computer-based instruction for adults?

The second step in the theory building method is to make explicit and specific the manner in which the units of the theory interact and relate to one another (Dubin, 1978; Torraco, 1994, 2000; Lynham, 2002). A law of interaction is a statement by the researcher-theorist of the relationship between units and shows how the units of the theory are linked to each other. The laws of interaction relate to the relationship between units of the theory and not to the conceptual dimension of each unit of the theory (Lynham, 2002). The laws of interaction do not necessarily indicate causality (Dubin, 1978; Lynham, 2002). Dubin (1978) informed us that laws of interaction are never themselves measured; rather, the values of the units in a relationship are measured. There are three general categories or types of laws of interaction as highlighted by Dubin (1978): categoric, sequential, and determinant.

Categoric laws of interaction indicate the values of a unit of the theory are associated with values of another unit. Categoric laws of interaction are symmetrical in nature and typically use “is associated with” in the law of interaction.

Sequential laws of interaction make use of a time dimension to describe the relationships between two or more units. A sequential law of interaction identifies a temporal interval between the values of two or more units and indicates that the relationship between the units concerned is unidirectional (Lynham, 2002). Sequential laws are asymmetrical with a time lapse between the units. Sequential laws of interaction employ “succeeded by or preceded by” with a time interval (Dubin, 1978).

A determinant law of interaction is one that relates determinate values of one unit of the theory with determinate values of another unit. Determinant laws of interaction describe specific relationships between units with determinate values and are typically used in the physical sciences (Dubin, 1978; Torraco, 2000; Lynham, 2002).

The laws of interaction show how changes in one or more of the units of the theory influence the remaining units and enable the research-theorist to answer the second objective of the study: What are the laws of interaction of a theory of effective computer-based instruction for adults? These first two steps provide the major contribution to knowledge that is generated by theory (Dubin, 1978; Lynham, 2002; Torraco, 1994, 1997, 2000).

The third step is to determine the limited domain of the world in which the theory is expected to hold true. Determining the boundaries of the theory enables the research to set and clarify the aspects of the real world that the theory is attempting to model. In setting the

boundaries, it distinguishes the theoretical domain of the theory from those aspects of the real world not addressed or explained by the theory (Lynham, 2002). In determining the boundaries of the theory, the researcher-theorist will answer the third objective of the study: What are the boundaries of a theory of effective computer-based instruction for adults?

The fourth step and final step in the theory development part is the specification of the system states of the theory. System states indicate the complexity of the real world that the theory is presumed to represent and the different conditions under which the theory operates.

A system state is a state of the system as a whole and represents a condition under which the theory is operative. All units of the system states are determinant and measurable and are distinctive for each state of the theoretical system (Dubin, 1978; Torraco, 1994; Lynham, 2002). In determining the system states of the theory, the researcher-theorist will answer the fourth objective of the study: What are the system states of a theory of effective computer-based instruction for adults? These first four steps constitute the conceptual development of the theory and provide the theoretical framework of the theory.

The first step in the research operation and the fifth step of the applied theory building method involve specifying the propositions of the theory. A proposition of a theoretical model is a truth statement about the model in operation (Dubin, 1978). These propositions are grounded in the explanatory and predictive power embedded in the theoretical framework constructed during theory development process (Lynham, 2002). The researcher-theorist will provide the answer to the last objective in this step: What are the propositions of a theory of

computer-based instruction for adults? Once these five steps are completed, the researcher-theorist has developed the theory and can begin testing the theory.

The sixth step is the identification of the empirical indicators of the theory. Identifying empirical indicators is necessary to make the proposition statements testable and is needed for each unit in each proposition for which a test is sought (Dubin, 1978; Lynham, 2002).

The seventh step in the applied theory building method is constructing hypotheses. A hypothesis may be defined as the prediction about values of units of a theory in which empirical indicators are employed for the named units in each proposition. The linkage between the empirical world and the theory is found in the hypotheses that mirror the propositions of the model (Dubin, 1978).

The eighth and final step in Dubin's theory building process is to engage in the actual testing of the theory through a thoughtful specified research plan of ongoing data gathering to enable adequate verification and/or continuous refinement of the theory (Lynham, 2002). Theory building in an applied field such as Human Resource Development is dynamic with testing and refining of the theory being a challenge and the responsibility of researchers in the field. Dubin's methodology for theory building is used to develop a theory of computer-based instruction for adults.

Evaluating Theory

Without the empirical testing of a theory in step eight of Dubin's methodology, theories cannot be evaluated as to their correctness or validity. A theory may be good

without being totally correct. However, a good theory is more likely to be true than a poor one. Patterson (1986, p. xx) provides eight criteria for evaluating a theory.

1. Importance. A theory should not be trivial but should be significant. It should be applicable to more than a limited restricted situation. It should have some relevance to life. Importance is very difficult to evaluate since the criteria are vague or subjective. Acceptance by competent professionals or recognition and persistence in the professional literature may be indicative of importance. If theory meets other formal criteria, it is probably important.
2. Preciseness and Clarity. A theory should be understandable, internally consistent, and free from ambiguities. Clarity may be tested by the ease of relating the theory to data or practice. The ease of developing the hypotheses, which is the last step of this study, is another way of testing clarity.
3. Parsimony or Simplicity. Parsimony has long been accepted as a characteristic of a good theory. A good theory contains a minimum of complexity and few assumptions. The phenomena of the world and of nature are relatively simple in terms of basic principles. The law of parsimony appears to be the most widely violated in theory construction because of the stage of knowledge the theorist has reached, where diversity and complexity are more apparent than are the underlying unity and consistency. Hall and Lindzey (1970) propose that parsimony is important only after the criteria of comprehensiveness and verifiability have been met.

4. Comprehensiveness. A theory should be complete, covering the area of interest and including all known data in the field. The area of interest can be restricted.
5. Operationality. A theory should be capable of being reduced to procedures for testing its propositions or predictions. Its concepts must be precise enough to be measurable. A lack of measurement to operationalize a concept should not rule out the use of a concept that is essential for a theory. The concept first should be defined and then a method of measurement chosen or developed. Not all concepts of a theory need to be operational; concepts may be used to indicate relationships and organization among concepts.
6. Empirical Validity or Verifiability. A theory must be supported by experience and experiments that confirm the theory. In addition to its consistency with or ability to account for what is already known, it must generate new knowledge. A theory that is disconfirmed by experiment may lead indirectly to new knowledge by stimulating the development of a better theory.
7. Fruitfulness. The capacity of a theory to lead to predictions that can be tested, when in turn leads to the development of new knowledge, has often been referred to as its fruitfulness. A theory can be fruitful even if it is not capable of leading to specific predictions. It may provoke thinking and the development of new ideas or theories because it leads to disbelief or resistance in others.
8. Practicality. The final criterion of a good theory is its usefulness to practitioners in organizing their thinking and practice by providing a conceptual framework for

practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles. Practitioners too often think of theory as something that is irrelevant to what they do, unrelated to practice or to real life. There is nothing as practical as a good theory (Lewin, 1951).

The Role of Theory Building in Human Resource Development

The potential value of theory for guiding scientific understanding, explanation, and prediction cuts across all professional disciplines. The roles that theory serves in HRD are essentially the same as those served by theory in other disciplines. Theory provides members of a professional discipline with a common language and a frame of reference for defining boundaries of their profession. Torraco (1994, 1997, p. 117) identified seven prominent roles served by theory in the context of human resource development.

1. Interpreting new research data. Theory provides a means by which new research data can be interpreted and coded for future use. For example, research is currently generating a great deal of data on the effects of transformed organizational structures (e.g., flatter designs, and “downsized” organization). Organizational behavior theory maintains that as the organizational structure changes, new relationships emerge among the individuals who function within the organization. Theory is warning us that we must pay more attention to changing employee roles as organizations take on new forms.
2. Responding to new problems. Theory provides a means for responding to new

problems that have no previously identified solutions strategy. Consider the case of technologically advanced work environments that remove workers further from concrete cues to performance, this increasingly contributes to the worker's anxiety and operational errors. Theories of work design and human motivation tell us that frequent feedback that is procedure-specific increases worker satisfaction and accuracy of performance. Knowledge from these theories can be applied to new work environments.

3. Defining applied problems. Theory provides a means for identifying and defining applied problems. For instance, work performance problems are often defined in terms of training solutions. Yet, theories of performance maintain that work performance has multiple determinants; knowledge and skill interact with ability, motivation, and environmental factors to produce the outcomes of performance.
4. Evaluating solutions. Theory provides a means for prescribing or evaluating solutions to applied problems. Organizational leaders often look to outside agents as the means for effecting change in their organizations. Yet organizational change theory suggests that the direction and commitment for change and criteria for its success must come primarily from within the organization itself.
5. Discerning priorities. Theory tells us that certain facts among the accumulated knowledge are important and others are not. For example, theories of learning and instruction suggest that the learning goal to be achieved is more important than the speed of achieving it. Theories of learning and instruction also suggest

that the match between the instructional method and the capability to be learned is more important than the choice of media. Finally, theories of learning and instruction suggest that the type of evaluation is often less important than assuring that some form of evaluation is used to demonstrate effectiveness.

6. Interpreting old data in new ways. Theory gives old data new interpretations and new meaning. For example, theories of motivation have recast the importance of extrinsic motivators for work, such as pay and perquisites. The use of money has had unintended consequences in cases where it has undermined the intrinsic rewards of work and in cases where increasing the pay of one person has demotivated everyone else.
7. Identifying new research directions. Theory identifies important new issues and prescribes the most critical research questions that need to be answered to maximize understanding of the issue. For example, an environment of increasingly scarce economic resources portends diminishing investments in human resource development. Yet human capital theory challenges the HRD profession to reframe this issue into one in which greater depth of human capital contributes to the renewal and expansion of human and economic resources.

Authors in HRD agree that theory and theory building are very important in guiding the practice and advancing the profession as a whole (Bacharach, 1989; Chalofsky, 1998; Dubin, 1976; Gioia & Pitre, 1990; Hardy, 1999; Hatcher, 1999; Holton, 2002; Marsick, 1990; Mott, 1998; Passmore, 1997; Ruona & Lynham, 1999; Swanson & Holton, 1997; Torraco,

1997; Van de Ven, 1989). Lynham (2000, p. 162) provided three reasons theory building is important to the HRD profession:

1. To advance professionalism and maturity in HRD. Many scholars in the field believe that the development of good theory in HRD is essential for the maturation and professionalization of HRD (Chalofsky, 1998; Hatcher, 1999; Marsick, 1990; 1998; Mott, 1998; Swanson & Holton, 1997; Torraco, 1997)
2. To dissolve the tension between HRD research and practice. Research-practitioner partnering is perceived as a way to step up to the challenges of professionalizing and maturing the HRD field.
3. To develop multiple, inclusive methods of research for theory building and practice in HRD. When theory is perceived and built from multiple research perspectives, the results are more comprehensive, inclusive and complete view of human/social and organizational phenomena.

A profession's theory base prescribes both the knowledge domains and scope of practice over which a profession claims to have expertise. The depth of the theory base should be directly related to the scope of practice. A key role of theory is to guide and inform research so that it can, in turn, guide development efforts and improve professional practice. As a conceptual foundation for research and practice, theory serves a critical role in the advancement of the HRD profession (Torraco, 1997).

General Learning Theories

Learning as a process focuses on what happens when learning takes place. The explanation of what happens is called learning theories. Hill (1971) reported two chief values of learning theories: to provide a vocabulary and conceptual framework for interpreting examples of learning that is observed and to suggest where to look for solutions to practical problems. Learning theories are chiefly descriptive. There is little consensus on how many learning theories there are or how they should be grouped. Merriam and Caffarella (1999) identified behaviorism, cognitivism, social learning, humanist, and constructivism theories as key theories of adult learning. This study will use these five theories of adult learning as a conceptual framework.

Behavioral Learning Theory

Behavioral learning theory was developed by Watson in the early decades of the twentieth century and loosely encompasses the work of Thorndike, Tolman, Guthrie, Hull, and Skinner (Ormrod, 1995). Skinner's theory of operant conditioning had a tremendous influence on the development of the early CBI systems (Shlechter, 1991). The basic learning principles of Skinner's theory are personalized instruction, controlled operant, immediate feedback, linear sequence of learning, and instructional prompts (Shlechter, 1991). Another approach to instruction, devised by Crowder (1962) and involving the use of a branching sequence in CBI for training Navy personnel was the basis for adaptive sequencing.

There are three basic assumptions about the behavioral learning process: (1) behavior rather than internal thought processes is the focus, (2) environment shapes behavior, and (3)

the principle of contiguity and reinforcement are central to explain the learning process (Grippin & Peters, 1983). Several educational practices can be traced to the behavioral type of learning. The systematic design of instruction, behavioral objectives, notions of the instructor's accountability, programmed instruction, computer-assisted instruction, and competency-based education are all solidly grounded in behavioral learning theory. Adult technical and skills training also draws from behaviorism.

Training researchers continue to endorse, explicitly or implicitly, a methodological behaviorism that stresses the importance of objective, observable performance as the primary indicator of training output (Bosco & Morrison, 2000). The concept of behavioral objectives continues to serve as a method for defining the content of instruction. Wells and Hagman (1989) have demonstrated that objectives have a positive effect on learning at the individual level. In the 1960's and 1970's, as behavioristic learning theory was peaking in its influence on training research and practice, learning theorists were becoming less satisfied with behavioral conceptions of learning and memory and increasingly interested in the study of internal knowledge structures and cognitive processes that underlie task performance (Bosco & Morrison, 2000). The positive effects of behavioral objectives and the learning process are now discussed in cognitive rather than behavioral terms.

Cognitive Learning Theory

A break from behaviorism occurred with the importation of the notion of insight learning in the gestalt theories of Wertheimer, Kiffka, and Kohler (Moore & Fitz, 1993). These theorists took issue with the proposition that all learning consisted of the simple

connection of responses to stimuli. They insisted that experience is always structured and that we react to a complex pattern of stimuli. The learner perceives stimuli in organized wholes, not in disconnected parts. The learner organizes his/her perceptual field according to four laws: (1) the law of proximity, (2) the law of similarity and familiarity, (3) the law of closure, and (4) the law of continuation. Gestalt psychology is classified within the family of field theories where the total pattern or field, stimuli, or events determine learning.

Perception, insight and meaning are key contributions to cognitivism from Gestalt learning theorists (Merriam & Caffarella, 1999). A major difference between Gestaltists and behaviorists is the locus of control over the learning activity. For Gestaltists it lies with the individual learner and for behaviorists it lies with the environment. The shift to the individual and the learner's mental processes is characteristic of cognitivist-oriented learning theories.

Most contemporary cognitive psychologists hold that learning consists of individual constructions of knowledge. Learning is a personal event that results from sustained and meaningful engagement with one's environment (Bruner, 1961, 1985, 1986). This view also holds that learning cannot be viewed apart from the social and cultural contexts in which it occurs (Prawat & Floden, 1994).

Lewin developed what he referred to as a field theory. According to his theory, each individual exists in a life space in which many forces are operating in the environment. Behavior is the product of the interplay of those forces; the direction and relative strength of which can be portrayed by the geometry of vectors. Learning occurs as a result of a change in

cognitive structures produced by changes in two types of forces: change in the structure of the cognitive field itself, or change in the internal needs or motivation of the individual. Lewin saw success as more potent motivating force than reward and gave attention to the concepts of ego-involvement and level of aspiration as forces affecting success. He felt that the urge for self-actualization is the driving force motivating all human behavior (Knowles, Holton, & Swanson, 1998).

Piaget and Bruner focused on the cognition and theory of instruction, which had an impact on learning theories. Piaget (1972) conceptualized behavior of the human organism as starting with the organization of sensory-motor reactions and becoming more intelligent as coordination between reactions to objects becomes progressively more interrelated and complex. A basic assumption of Piaget's theory is that a different type of assimilation and accommodation occurs at each stage of development (Flavell, 1968). A person must wait until the final stage of development, the formal operational stage, to develop the cognitive structures necessary for dealing with abstract environmental relationships (Shlechter, 1991). Thinking becomes possible after language develops and a new mental organization is created.

Piaget's theory of cognitive development influenced many CBI designers. Papert (1980), who helped design the LOGO system (a programming language for children), was greatly influenced by Piaget's theory. While basically agreeing with Piaget about the assimilation and accommodation process, Papert (1980) argues that cognitive development can be expedited by providing the student more formal operational experiences. A student can acquire these needed experiences by programming a computer with the LOGO authoring

language (Papert, 1980). Using and combining different commands to form a coherent computer graphic and debugging a program are examples of formal operational experiences. The cognitive influence became more prevalent as computer technology became more sophisticated (Shlechter, 1991).

Bruner's (Knowles, 1984) interest was in the structuring and sequencing of knowledge and translating this into a theory of instruction. He did, however, have a basic theory about the act of learning which he viewed as involving three almost simultaneous processes: acquisition of new information, transformation or manipulating knowledge to make it fit new tasks, and evaluation to see if information is adequate to the task.

Gardner (1985, p. 6) defines cognitive science as "a contemporary, empirically based effort to answer long-standing epistemological questions, particularly those concerned with the nature of knowledge, its components, its sources, its development and its deployment." Three features cited by Gardner generally associated with cognitive science that apply to computer-based instruction are: (1) cognitive science is explicitly multi-disciplinary, drawing especially upon the disciplines of psychology, linguistics, anthropology, philosophy, neuroscience, and artificial intelligence; (2) a central issue for this discipline is cognitive representation, its form, structure, and embodiment at various levels; and (3) the faith that the computer will prove central to the solution of problems of cognitive science, both in the conduct of research to investigate various cognitive representations and in providing viable models of the thought process itself (Bednar et al., 1995).

Bednar and his colleagues (1995) refer to knowledge as some entity existing independent of the mind of individuals and which is transferred “inside.” Consistent with this view of knowledge, the goal of instruction, from both the behavioral and cognitive information processing perspectives, is to communicate or transfer knowledge to learners in the most efficient, effective manner possible. Knowledge can be completely characterized using the techniques of semantic analysis. One key to efficiency and effectiveness is simplification and regularization: thought is atomistic in that it can be completely broken down into simple building blocks, which form the basis for instruction. Thus, the transfer of knowledge is most efficient if the excess baggage of irrelevant content and context can be eliminated. While behaviorist applications focus on the design of learning environments that optimize knowledge transfer, cognitive information processing stresses efficient processing strategies (Bednar et al., 1995).

Bosco & Morrison (2000) reported that cognitive theory is now the dominant theoretical viewpoint in research on learning and memory resulting in two notable trends: (1) the greater use of mental constructs to define task requirements, through the cognitive task analysis method, and (2) the greater willingness to devise training interventions for mentally demanding tasks. Glaser (1990) reviewed cognitive research and reported that learning processes and instructional implications showed very few commonalities across the task domains. He was confident that an integrated theory would eventually be designed to prescribe a mix of instructional approaches for specific training purposes.

Contemporary approaches to computer-based learning are more often rooted in cognitive learning theories. They focus not on the product technology of the computer but on the idea technologies afforded by the computer (Hooper & Rieber, 1995). Idea technologies tend to emphasize constructivist orientations to learning (Papert, 1981, 1993; Schwartz, Yerushalmy & Wilson, 1993; White, 1993). The effects of technology on learning can best be understood when classified as “effects of” versus “with” the computer on cognition (Salomon, Perkins & Globerson, 1991).

Research on the effects of the computer on cognition attempts to determine if cognitive residue results as a consequence of the interaction between the individual and computer, such as an increase in general problem-solving ability or mathematical reasoning. Research with technology focuses on how human processing changes in distinct, qualitative ways when an individual is engaged in an intellectual activity using the computer as a tool. Taken interactively, an intellectual partnership is formed between the individual and the technology; the resulting changes to cognition cannot be understood when the individual or the technology is considered apart (Hannafin et al., 1996). An emphasis on learning with media, as opposed to learning from media, may help to resolve some of the debate and controversy surrounding media research (Clark, 1983; Kozma, 1991b).

Social Learning Theory

Social learning theory which combines elements from both behaviorist and cognitivist orientations suggests that people learn from observing others. It was not until the 1960's that Bandura focused more on the cognitive processes involved in the observation of subsequent

behavior. “Virtually all learning phenomena resulting from direct experiences can occur on a vicarious basis through observation of the people’s behavior and its consequences for the observer” (Bandura, 1976, p. 392). Bandura’s observational learning is characterized by the concept of self-regulation.

The four processes of attention, retention or memory, behavioral rehearsal, and motivation influence observational learning. More recently, Bandura has focused on self-efficacy as it influences learning (Merriam & Caffarella, 1999). Bandura’s theory has particular relevance to adult learning in that it accounts for both the learner and the environment in which he or she operates. Behavior is a function of the interaction of the person with the environment. This is a reciprocal concept in that people influence their environment, which in turn influences the way they behave (Merriam & Caffarella, 1999).

Rotter’s (1954) theory assumes that much of human behavior takes place in a meaningful environment and is acquired through social interactions with other people. Seven propositions and attendant corollaries that delineate relationships among the concepts of behavior, personality, experience, and environment frame his theory. Rotter’s theory assumes “that much of human behavior takes place in a meaningful environment and is acquired through social interaction with other people” (Phares, 1980, p. 406).

Key to understanding which behavior in the individual’s repertoire will occur in a given situation is the concepts of expectancy and reinforcement (Merriam & Caffarella, 1999). Expectancy is the likelihood that a particular reinforcement will occur as the result of specific behavior. The motivation to engage in adult learning activities might be partly

explained by Rotter's notion of locus of control. Another connection to adult learning for the social learning theory is the importance of context and the learner's interaction with the environment to explain behavior.

Humanist Learning Theory

Humanist theories consider learning from the perspective of the human potential for growth. Humanists refuse to accept the notion that either the environment predetermines behavior or one's subconscious. Rather, human beings can control their own destiny; people are inherently good and will strive for a better world; people are free to act, behavior is the consequence of human choice; and people possess unlimited potential for growth and development (Rogers, 1983). From a learning theory perspective, humanism emphasizes that perceptions are centered in experience, as well as the freedom and responsibility to become what one is capable of becoming. These principles underlie much of adult learning theory that stresses the self-directedness of adults and the value of experience in the learning process.

Rogers' (1983) client-centered therapy is often equated with student-centered learning. He believed that learning should: include personal involvement; involve both affective and cognitive aspects of a person; be self-initiated - a sense of discovery must come from within; be pervasive - the learning makes a difference in the behavior, attitudes, perhaps even the personality of the learner; be evaluated by the learner - the learner can best determine whether the experience is meeting a need; and focus on experiential learning -

when experiential learning takes place, its meaning to the learner becomes incorporated into the total experience.

Constructivism Learning Theory

The historical roots of constructivism are most heavily grounded in developmental psychology and social learning theories. A constructivist maintains that learning is a process of constructing meaning. Meaning is made by the individual and is dependent on the individual's previous and current knowledge structure. Learning also involves providing experiences that induce cognitive conflict, and hence, encourages learners to develop new knowledge schemes that are better adapted to experience. To a constructivist, learning must be situated in a rich context, reflective of real world contexts, for this constructive process to occur and transfer to environments beyond the training classroom (Bednar et al., 1995). How effective or instrumental the learner's knowledge structure is in facilitating thinking in the content field is the measure of learning.

The learner must construct an understanding or viewpoint; the content cannot be pre-specified. While a core knowledge domain may be specified, the student is encouraged to search for other relevant knowledge domains that may be relevant to the issue. It is clear that knowledge domains are not readily separated in the world; information from many sources bears on the analysis of any issue. A central or core body of information must be defined; however, the boundaries of what may be relevant cannot be defined (Bednar et al., 1995). The constructivist view does not accept the assumption that types of learning can be identified independent of the content and the context of learning. It is not possible to isolate

units of information or make a priori assumption of how the information will be used.

Instead of dividing up the knowledge domain based on a logical analysis of dependencies, the constructivist view turns toward a consideration of what real people in a particular knowledge domain and real life context typically do (Brown, Collins, & Duguid, 1989; Resnick, 1987).

The overarching goal of such an approach is to move the learner into thinking in the knowledge domain as an expert user of that domain might think. The goal should be to portray tasks and not to define the structure of learning required for achieving a task. It is the process of constructing a perspective or understanding that is essential to learning; no meaningful construction is possible if all relevant information is pre-specified (Bednar et al., 1995).

Andragogy

Andragogy is the art and science of teaching adults (Knowles, 1978). Andragogy is a set of core adult learning principles that apply to all adult learning situations. The six principles of Andragogy defined by Knowles (1998) are: (1) the learner's need to know, (2) self-concept of the learner, (3) prior experience of the learner, (4) readiness to learn, (5) orientation to learning, and (6) motivation to learn. They are based on assumptions about the adult learner.

1. The need to know. Adults need to know why they need to learn something before undertaking to learn it. Even in learning situations in which the learning content is prescribed, sharing control over the learning strategies is believed to make learning more effective (Knowles, et al., 1998). Adults need to know the how,

what and why of learning before learning can take place. The first task of the facilitator of learning is to help the learners become aware of the need to know.

2. The learners' self-concept. Adults have a self-concept of being responsible for their own decisions, for their own lives. They develop a deep psychological need to be seen by others and treated by others as being capable of self-direction. Tough (1979) found that when adults undertake to learn something on their own, they will invest considerable energy in probing into the benefits they will gain from learning it and the negative consequences of not learning it. The facilitator should create learning experiences in which adults are helped to make the transition from dependent to self-directing learners.
3. The role of the learners' experiences. Adults come into an educational activity with both quantity and quality of experiences. In any group of adults there will be a wide range of individual differences in terms of background, learning style, motivation, needs, interest, and goals. Experience is who the adult is. Hence the emphasis in adult education is placed on individualization of teaching and learning strategies. The facilitator should make the adults' experiences a part of the learning opportunity.
4. Readiness to learn. Adults become ready to learn those things they need to know and be able to do in order to cope effectively with their real-life situations. The critical implication of this assumption is the importance of timing learning experiences to coincide with those developmental tasks. The facilitator should

induce readiness through exposure to models of superior performance, simulation exercises, and other techniques.

5. Orientation to learning. Adults are life-centered in their orientation to learning.

Adults are motivated to learn to the extent that they perceive that learning will help them perform tasks or deal with problems that they confront in their life situations. They learn most effectively when new knowledge, understandings, skills, values, and attitudes are presented in the context of application to real-life situations.

6. Motivation to learn. Tough (1979) found in his research that all normal adults are motivated to keep growing and developing, but this motivation is frequently blocked by barriers such as negative self-concept, inaccessibility of opportunities or resources, time constraints, and programs that violate principles of adult learning. Adults are primarily motivated by the internal pressures such as increased job satisfaction, self-esteem, and quality of life.

There are a variety of other factors that affect adult learning in any particular situation and may cause adults to behave more or less closely to the core principles. These include individual learner differences, situational differences, and goals and purposes of learning. Andragogy works best in practice when it is adapted to fit the uniqueness of the learners and the learning situation. The Andragogy in Practice model (Knowles et al., 1998) contains the six core adult learning principles in the middle. They serve as a sound foundation for planning adult learning experiences. Surrounding the core principles are two rings, the

outermost ring addresses the goals and purposes for learning and the innermost ring addresses the individual and situational differences.

The goals and purposes for learning include societal growth, individual growth, and institutional growth. Adult learning is equally powerful in developing better institutions and societies as well as individuals. The goals and purposes for which the adult learning is conducted provide a frame that puts shape to the learning experience (Knowles et al., 1998). Emphasis on the core learning principles will be modified based on the goals and purposes of the adult learner.

The individual and situational differences include situational differences, individual learner differences, and subject matter differences. These differences act as a filter that shapes the practice of andragogy. Analysis should be conducted to understand the particular adult learners and their individual characteristics, the characteristics of the subject matter, and the characteristics of the particular situation in which adult learning is being used. Each of these factors will change the extent to which the core principles of andragogy are applicable to specific learners in a specific learning situation. The facilitator may place greater emphasis on a particular principle based on this analysis.

Regardless of their different learning styles and abilities, people increasingly want to be active rather than passive learners (Albright & Post, 1993). They seek to learn at their own paces and to learn at the right time so that they can apply new knowledge and skills immediately. The effective use of electronic performance support depends on skills-based instruction in which trainees not only learn new skills but also practice them.

A study at the University of Georgia examined different ways adults learn software, based on their learning styles and preferences, type of work and experience (Harp et al, 1997). The study indicated that dependent learners generally prefer a direct approach; self-directed learners generally prefer an autonomous approach. Self-directed learners like more control over what, when and how to learn. Dependent learners prefer one-on-one discussions with trainers and consultants. Self-directed learners find it more useful to experiment with software and search menus. Respondents reported that co-workers were available learning resources as compared to support staff that solved the problem without explaining how. The respondents in this study reported that watching videos, attending user support groups, and referring to the training manuals were the least useful learning activities.

The andragogical model is a process model. The andragogical teacher (facilitator) prepares, in advance, a set of procedures for involving the learner in a process. This process involves these elements: establishing a climate conducive to learning; creating a mechanism for mutual planning; diagnosing the needs for learning; formulating program objectives that will satisfy these needs; designing a pattern of learning experiences; conducting these learning experiences with suitable techniques and materials; and evaluating the learning outcomes and rediagnosing learning needs (Knowles, 1978). The process model is concerned with providing procedures and resources for helping learners acquire information and skills.

Wiswell and Ward (1997) found that changes in both computer technology and the context in which it operates necessitate a new approach to training that incorporates constructivist and andragogical practices to deliver a more learner-centered experience. In

their action research study of training implementation at three federal agencies, each setting had a mandate for a comprehensive, organization-wide training program for a particular training need. Each setting also had a unique set of learner needs to be addressed. Learning was found to occur in an almost endless variety of ways. Three dimensions in particular appeared to describe important characteristics to each variety of learning: content, context, and control (Wiswell & Ward, 1997).

Computer-Based Instruction Theory Building

It is only within the last decade that framework development for CBI has become a part of the literature. Prior to this time, researchers' studies compared CBI to traditional classroom instruction or analyzed the constructs mentioned in Chapter 1 to determine the variables that influenced learning by means of the computer. It was not until researchers began to analyze these studies through meta-analysis and review theses meta-analyses that researchers of CBI began to realize that there were confounding variables that could render the research invalid.

The continuing progress made by cognitive psychologists in research on how we learn and the better understanding of the constructivism approach to learning have provided researchers an opportunity to considered combining learning theories in developing their frameworks for CBI. The literature on development of frameworks or models for computer-based instruction is limited. The articles that were found to include a framework for CBI (Johnson & Aragon, 2002; Kember & Murphy, 1990; Steinberg, 1991; Williams, 2000) concluded that a synthesis of the learning theories is part of their framework. These

researchers have begun to develop frameworks that provide a strategy for future empirical research. However, it is this researcher's opinion that these frameworks do not represent all the critical components that are needed to develop a theory of effective computer-based instruction for adults.

Johnson and Aragon

Johnson & Aragon (2002) have begun developing a framework for instructional strategies for use in the computer learning environment. They reviewed numerous studies (Clark, 1999; Johnson, Aragon, Shaik, & Palma-Rivas, 2000; Navarro & Shoemaker, 1999; Smeaton & Keogh, 1999) comparing traditional classroom instruction with technology-supported instruction and found no significant differences. The obvious conclusion was that the technology used to support instruction has little impact on the learner's attainment of educational outcomes. Based on the lack of evidence that technology significantly influences the learning process, scholars in the field of instructional technology now conclude that the technology used in an online program is not as important as other instructional factors, such as pedagogy and course design (Phipps & Merisotis, 1999).

Johnson and Aragon (2002) created a learning environment to support an online graduate course that was based on the assumption that learning is a complex event that cannot be explained with a single theory of learning. The researchers hypothesized that quality learning environments should be based on instructional principles that are derived from multiple learning theories.

Instructional designers need to look for innovative ways to support quality teaching

and learning without succumbing to the temptation to have online instruction become direct instantiations of traditional forms of instruction (Johnson & Aragon, 2002). The challenge is to devise ways to create pedagogically sound content for delivery by means of the computer. Johnson and Aragon contend that online learning environments need to contain a combination of these principles: (1) address individual differences, (2) motivate the student, (3) avoid information overload, (4) create a real-life context, (5) encourage social interaction, (6) provide hands-on activities, and (7) encourage student reflection. They suggested that quality online learning environments should be comprised of elements of behavioral, cognitive and social learning theory. Adopting a synthesized theory of learning can have a synergistic result by integrating the most positive and powerful aspects of each individual learning theory into an online learning environment (Johnson & Aragon, 2002).

Kember and Murphy

Kember and Murphy (1990) suggested that instructional design theory and educational technology have been rooted in behavioral psychology. Instruction designed based on behavioral learning theory has been limiting and that new theories should be consistent with constructivist theories of psychology and allow flexible, pragmatic development approaches. They believe that for meaningful and lasting learning to occur, greater attention should be given to the constructivist paradigm, and specific techniques need to be devised and implemented which encourage deep learning. Approaches to instructional design need to be developed that don't just transmit knowledge, but are able to accomplish conceptual change in the student. That is, misconceptions in the learners need to be

analyzed, and techniques devised to help them to overcome such problems. “If teaching is the facilitation of learning, then efforts need to be concentrated on the learner rather than the instruction” (p.45).

Steinberg

CBI draws on learning theories, instructional models, practical experience and technology. For understanding how these domains contribute to computer-based instruction, Steinberg (1991) developed a six-component framework for computer-based instruction. Four components were derived from learning theories and instruction models: target population, goals, task, and instruction. Two of the components, computer application and environmental implementation, reflect research and experience with CBI. Steinberg synthesizes theories of Bransford (1979) and Gagné (1977) in developing her framework.

Bransford’s theory explores learning, remembering, and understanding from a process perspective. His framework consists of four components: learner characteristics, criterial task, nature of materials to be learned, and nature of learning activities. Bransford emphasizes that the most significant idea underlying this framework is the interaction among components (Steinberg, 1991).

Gagné conceptualizes learning in terms of categories of skills and capabilities and the conditions under which they are learned. Gagné groups the diverse outcomes of learning into five categories: intellectual skills, verbal information, cognitive strategies, motor skills, and attitudes. Elements both within each person and in the surrounding environment affect learning. Each type of learning outcome occurs under its own set of internal and external

conditions. Gagné's theory suggest that both attributes of the learner and events in the environment contribute to learning, and each type of learning outcome has its own set of internal and external conditions.

From Steinberg's synthesis of Bransford's and Gagné's theories, she concluded that four components are central to learning, regardless of the theoretical perspective: target population (who is learning), goals (what they are supposed to learn), task (the materials and skills involved), and instruction (the externally planned activities).

When one looks at the target population, there are many individual differences. The many characteristics of learners affect their ability to learn and to acquire new knowledge. An individual's subject-specific knowledge and general knowledge both affect comprehension. A general characteristic of all human beings is that they have a limited capacity to process information. Too much information presented simultaneously is not likely to be learned and remembered.

Goals, the second component, are the expected outcomes of instruction. Goals in CBI may be lesson or computer determined. CBI goals include demonstrating knowledge or skill, engaging in a simulated experience such as decision making, learning how to learn, or influencing attitudes.

The third component of Steinberg's model is task. The skills and processes involved in a task vary with the subject matter and the nature of the materials. Each subject matter domain has its own subject-specific skills but it also has some skills in common with other domains. Learning verbal material involves different skills than visual. A single set of

materials may be more or less complex, and require different skills depending on the task.

Instruction is the fourth component of Steinberg's model. Some instructional models evolve from common wisdom and experience successfully teaching a given subject. Other models are based on psychological theories of learning or on a combination of experience and theory. Computers are excellent vehicles for implementing well-established models of instruction. CBI can support models of instruction that are not possible in other modes.

Computer application means first and foremost the application of sound instructional principles. Appropriately utilized, the computer is a superb instructional tool. The computer is an appropriate instructional medium if the lesson it presents is effective, efficient, and acceptable to the intended learners (Steinberg, 1984).

The sixth component in the framework relates to the environment in which CBI is implemented. A match between the anticipated and the actual conditions in which learning takes place is essential.

Each of these six components is necessary, but the crucial aspect of the framework for CBI is that learning is significantly affected by the interaction of these components. For example, a computer can be used to implement many models of instruction but if the computer application is poor or if the model is inappropriate for the target population, there will probably be little or no learning. The critical idea of this framework of CBI is that the components interact to affect learning and they do not act independently.

Williams

Williams (2000) found that there were several different views of what learning theory

best fits learning by means of the computer. Behaviorism has historically had the greatest impact on the online learning environment. However, more courses are being designed with a cognitive view in mind. The current trend in teaching and learning tends to be constructivism, which is based in cognitive psychology. In learning situations, the behaviorist wants to take the learner and produce desired behaviors by controlling the environment, whereas the constructivist wants to see how learning occurs. Hence, both of these methods are critical to provide a rich learning climate. The nature of online learning provides a perfect vehicle to integrate behaviorist and constructivist theories in order to understand the totality of learning in an online environment (Williams, 2000).

An integration of behaviorist principles and constructivist principles may be best suited for online learning. Although historically the theory that undergirds these principles has not been combined, Williams' view is that a combination of these principles will create new principles for teaching and learning and will mold online methods and strategies.

These researchers agree that learning theories need to synthesize to include several different learning theories in the development of an effective learning environment for the computer-based environment.

Research on Computer-Based Instruction

Most of the early research studies on computer-based instruction compared computer-based instruction with instructor-led instruction. The studies tended to focus on the computer as the independent variable and thus assumed that the computer itself was somehow affecting the learning process (Thompson et al., 1993). Traditional achievement

measures were outcome measures. Typical dependant variables include final test scores and scores on standardized achievement tests. In many studies, there are no controls for either the curriculum content or the teaching methods. Often, different teachers are used for the computer-based instruction and traditional classroom instruction groups and no control was made for the teacher effect (Thompson et al., 1993).

The early research in CBI tended to concentrate on the effects of the computer on student learning, while more recent work is evaluating more specific independent variables. Current research tends to focus on computer environments that have the potential to improve student problem solving and information handling skills. Recent research and development efforts in computer based learning points toward radically changing the roles of teachers and students in schools. Computer environments are beginning to enable more active and individualized learning on the part of students and to encourage teachers to serve as facilitators of this learning rather than as deliverers of knowledge. These potential changes in teaching and learning, based on cognitive theory, could cause radical re-structuring of schools (Thompson et al., 1993).

The evidence supports the position that technology based teaching and learning is effective. People can learn using media and because of the improved instructional strategies and the enhanced materials, facilitated by media, they may learn more effectively and in some cases, more efficiently. Educational technology can facilitate the teaching and learning process and potentially make education richer and more stimulating by creating environments and presenting content not possible otherwise (Clark, 1983).

Some areas of research conducted in CBI and found in this literature review are: meta-analyses of CBI, individual differences, attitudes toward computers, support for learners, learner control, motivation and CBI, context of learning, cooperative learning and CBI, learning environment, and hypermedia learning environments.

Meta-Analyses of CBI

A means of looking at such studies is through meta-analysis. Meta-analysis allows the investigator to transform the features and outcomes of the studies into quantitative measures and examine statistically the relationship between the features and outcomes of the studies (Glass, 1976). The key concept in meta-analysis is effect size, a statistical measurement that indicates the degree of change in the subjects after treatment is applied.

In analyzing five meta-analyses conducted by Kulik, Kulik, and Cohen (1980); Kulik, Kulik, and Shwalb (1986); Kulik and Kulik (1986); Khalili and Shashaani (1994); and Liao (1998), computer-based instruction positively affected student achievement when compared to traditional classroom instruction (Lowe, 2002). Clark (1983) suggested that the positive effect of CBI might be the uncontrolled effects of instructional method or content differences between treatments that were compared. Many educators believe instructional methodology is the construct behind student achievement. Unless a research design can hold all the variables constant except CBI when compared to traditional classroom instruction, these results have limited validity.

Clark (1985) suggests that, when computer or computer attributes are found to influence student achievement, other variables may actually be influencing the outcome. In

each of the five meta-analyses listed above, effect size was positive for achievement as an outcome for CBI over conventional instruction. When CBI and traditional classroom instruction are delivered by the same person, the learning advantage for CBI is reduced to insignificant levels (Clark, 1985). Salomon (1991) pointed out that “no important impact can be expected when the same old activity is carried out with a technology that makes it a bit faster or easier, the activity itself has to change” (p. 8).

Roblyer (1988 cited in Thompson et al., 1993) compared later studies to those meta-analyses conducted by Kulik. Roblyer found that attitudes toward school and content areas were significant and positive. She suggested that improving students’ self-image and self-confidence through computer use was a variable that needed further study. Additional findings of Roblyer were:

- Computer applications were more effective for teaching mathematics than reading and language skills
- The greatest effects were found in the science studies, although few. The computer applications for teaching cognitive skills such as problem-solving and critical thinking yielded about the same effects as for reading and mathematics
- Specific computer application types such as drill and practice, tutorial, and simulation were difficult to analyze because of their relation to specific subject matter

- High positive effects were found in studies that used simulations for unstructured work.

Roblyer concludes “the effectiveness of various types of CBI applications varied according to the content area and the skill being taught” (p. 48).

Contrary to earlier results, Roblyer found that the effects of computer use were highest at the college level and lowest at the secondary level. She also found differences in effects of males and females to be inconclusive and suggested further study. The studies that focus on effects of specific attributes and uses of the computer on specific learner outcomes are difficult to combine and analyze. The majority of the cognitive dependant variables in the studies reviewed by Kulik and Roblyer used standardized achievement measures (Thompson et al., 1993).

Individual Differences

Harrison and Rainer’s (1992) study surveyed 776 knowledge workers from a university concerning the relationship between individual differences and computer skill. Based on their findings, individual difference variables associated with higher computer skill included: male gender, younger age, more experience with computers, an attitude of confidence regarding computers, lower math anxiety, and a creative cognitive style. Individual difference variables accounted for 56 percent of the variance associated with computer skill. Such powerful evidence of the influence of individual differences has several implications for managers, including training and education of end users, human resource decisions regarding recruitment and selection, the change process associated with the

introduction of new technology in the workplace, and the impacts of technological advances on individual end-user computing personnel.

The growth of end-use computing suggests that the hands-on use of computers is becoming an important behavior in effective job performance. Individual differences are essential determinants of work behavior (Terborg, 1981). Computer-oriented work behavior is controlled by external factors associated with the work environment (e.g., characteristics of the job, including technology, job scope, responsibility, physical comfort, etc.) and internal characteristics of the person (e.g., age, education, attitudes, perceptions, etc.) (Harrison & Rainer, 1992).

Nelson (1990) uses an interactionist psychology perspective to examine the impact of individual difference and situational factors on acceptance of information technology. Nelson argues that job characteristics or situational factors have received the majority of research attention. She concludes that most studies simply correlate individual characteristics with computer attitudes. Nelson also notes that studies examining individual differences do not completely address their impact on work outcomes.

Igbaria and Parasuraman (1989) conclude that prior research on individual differences and computer-related outcomes had limitations, including use of students as subjects, which limits the generalizability of results to employed adults; examined bivariate relationships of demographic and personality variables to computer-related outcomes; and lacked multivariate linkages among a variety of individual difference variables.

Managers of end-use computing need to be aware of the impact of individual differences on work behaviors if they wish to create an effective work environment (Harrison & Rainer, 1992). Researchers (Avner et al., 1980; Bok, 1986; Carrier, 1979) believe that computers are ideally suited to handle individual learning differences.

An important finding of Harrison & Rainer's study was the relationship between attitudes and computer skill, given that the individuals' attitudes toward an object (computer) influence their responses to that object (Fishbein & Ajzen, 1975). The results indicate that overcoming negative attitudes may remove one barrier preventing individuals from increasing their computer skill. Education and training can be used to overcome negative attitudes toward computers (Davis & Davis, 1990).

The aptitude training interaction paradigm in educational psychology emphasizes adapting instructional methods to meet individual characteristics (Cronbach & Snow, 1977). The basis for this approach is the critical importance of the prior knowledge and cognitive skills each person brings to the training process (Pintrich et al., 1986). Therefore, knowledge of individual characteristics will help organizations tailor techniques to train and educate their employees most effectively in computer use (Harrison & Rainer, 1992). Nelson and Cheney (1987) found that training was positively related to computer-related ability.

Harrison & Rainer's study also suggested that the employee who is less conforming to rules, social norms, and accepted work patterns is more likely to demonstrate advanced level computer skills. This finding adds support to the idea that highly skilled end user computing

personnel, who have less anxiety and negative attitudes, will be more likely to accept and adapt to information technology innovations.

Attitudes Toward Computers

Orr, Allen, and Poindexter (2001) also examined the relationship between computer attitude and experience, demographic and education, and personality type and learning style in their study. Conclusions drawn based on their findings were: (1) anxiety associated with computers may be reduced somewhat through formal classroom instruction; (2) students who have prior computer course experience are more positive about computers at the beginning of an introductory computer course than their peers with less computer-related course experience, but by the conclusion of the semester of instruction, this difference is negligible; (3) students who have work experience using computers have less anxiety, more confidence, and a greater liking of computers at the beginning of a computer course, but this work experience only affects the amount they like to use computers by the conclusion of the course; (4) students who own computers consistently report more positive attitudes toward computers; (5) males and females do not differ in their attitudes toward computers; and (6) older students tend to have more positive attitudes toward computers than younger students; however, (7) freshmen tend to be more positive about computers than upper classmen. Despite the technologically intensive society in which younger students grew up, researchers (Busch, 1995; Rosen & Maguire, 1990) report that age is not a factor in predicting computer attitudes.

Support for Learners

Hannafin and his colleagues (1996) argue that the issue with computer research should be how to best utilize computers to redefine, support, or compliment teaching and/or learning efforts rather than if computers are effective in promoting learning. Learners often experience difficulty accessing important lesson content due to poorly integrated knowledge or the complexity of lesson presentations. Some are easily disoriented because of the lesson structure, while others are unable to deal with the cognitive demands associated with increased decision making in hypermedia learning environments (Jonassen, 1989). Although computer-based instruction is often rich in opportunities for students to interact and receive feedback, designers often neglect to provide students with the support supplied by effective classroom teachers (Hawk, McLeod, & Jonassen, 1985). To support the learner, orienting activities are often provided to establish expectancies for, and perspectives on, forthcoming lesson content.

Verbal-orienting activities perform two cognitive functions. They cue important lesson content and help to link new with existing knowledge. Hannafin and Hughes (1986), in extrapolating research and theory to the design of interactive video, outlined several distinctions between learning that results from using explicit objectives derived from behaviorist traditions and advance organizers based in cognitive traditions.

The specificity of the learning objective is inversely related to transfer (Hannafin et al., 1996). Specific orienting activities incorporated within interactive video instruction promote intended learning selectively by eliciting greater attention to highlighted information

(Ho, Savenye & Haas, 1986). Explicitly stated learning outcomes often limit students' ability to use new information in situations that are dissimilar to those in which initial learning occurred. Advance organizers, in contrast, tend to simulate higher-level learning (Krahn & Blanchaer, 1986), but often fail to stimulate factual learning.

Orientation has evolved a different connotation in the study of hypermedia. Orientation is viewed as the individual's awareness of his or her location within a hypermedia system and the individual's capacity to respond meaningfully given these perceptions. The concept of disorientation, or of being lost in hyperspace (Edwards & Hardman, 1989), has been used to characterize the aimless state wherein users find themselves unable to determine where they are or what to do. Disorientation, in effect, is the product of insufficient initial orientation to the system and inadequate ongoing guidance in the nature and use of the system (Hannafin et al., 1996).

The impact of encoding support on student performance may be best understood within a meaningful learning conceptual model (Hannafin et al., 1996). Mayer (1993) outlined three phases through which learners must progress in order for learning to become meaningful. First, learners must select relevant information from that presented to them. Second, they must organize the information into a coherent outline. Finally, they must relate the outline to a structure or event with which they are familiar. When the first phase is not met, no learning occurs. When only the first phase is met, rote learning occurs. When the first two phases are met, non-meaningful and inflexible learning occur. Meaningful learning occurs only when the third phase has been reached. Mayer's framework is consistent with

Wittrock's (1990) generative learning model, which emphasizes improving learning by stimulating deeper processing. Generative learning stresses forming connections among information to be learned and linking these associations with each learner's knowledge and experiences (Hannafin et al., 1996).

Encoding support will be effective to the extent that it helps learners to select, organize, and integrate learning experiences within mental models that have been clearly formulated in memory (Bliss, 1994). To some degree, the specific activity must, by definition, be idiosyncratic because everyone differs in what is clearly understood. However, to a larger extent, the nature of the activity that brings about cognitive transformation may vary little from person to person (Hannafin et al., 1996).

One activity that appears to promote effective learning is error correction. Error identification helps learners recognize inadequacies in their mental models and stimulates deeper understanding. Bangert-Drowns, Kulik, Kulik, and Morgan (1991) noted that, counterintuitively, feedback often failed to benefit, and sometimes even lowered performance. Feedback must be used mindfully to be effective. Feedback is unlikely to benefit, and may even diminish learning when students simply reproduce correct answers. The nature of feedback is strongly related to its impact on learning. Kulhavy and Stock (1989) outline two feedback components necessary to improve learning in CBI: verification and elaboration. Verification indicates the accuracy of a response and elaboration refers to additional information made available to the student. Several studies have indicated that elaborative feedback is more effective than simple knowledge of correct results.

Pridemore and Klein (1991) found that students demonstrated higher posttest achievement after receiving information related to the accuracy of a response, the correct response, and a brief explanation about the correct answer compared to simply receiving a statement as to the accuracy of a response. Increases in achievement were accompanied by increases in reading time, suggesting that elaboration may also have improved the quantity of instruction. The effect of feedback on retrieval increases as error rates increase, as more opportunities for receiving elaborations are provided (Hannafin et al., 1996). Feedback can be used to clarify key elements of the response-learning task itself and be employed to provide strategic information as well as affective information. Research indicates that feedback is a valuable tool for correcting errors; it is timely, meaningful, and relevant (Hannafin, Hannafin & Dalton, 1993).

Learner Control

Perhaps no single topic has received as much attention by researchers as that of locus of instruction control (Hannafin et al., 1996). The benefits and liabilities of learner control are well-documented (Steinberg, 1977, 1989). Learner control has been found to stimulate achievement and improve attitudes and motivation (Kinzie, 1990; Kinzie & Berdel, 1990; Lepper, 1985; Pollock & Sullivan, 1990). Kohn (1993) noted that learner control improved self-attribution, achievement, and behavior. On the other hand, learners have also proved poor judges of their learning needs, often seeking information that is not needed or terminating lessons prematurely (Hannafin, 1984).

Linear lessons and all program-controlled instruction are inherently structured. The

nature of the structure either limits or manages individual variability. Linear structures provide no opportunity for students to engage selectively in activities deemed uniquely appropriate, emphasizing instead activities thought to be of greatest value to all. Generally, complete program control has been effective for domain novices and for tasks with explicit performance requirement (Chung & Reigeluth, 1992). Highly structured environments are likely to be especially limiting for high-ability and high prior-knowledge students (Hannafin et al., 1996).

Varying learner control often accommodates differences in learner preferences, knowledge, and styles. In cases of optimal learner control, students individually identify what they will study and seek and revisit lesson segments as they evolve new representations. Doing so involves exploring learning environments many times and from many different perspectives (Spiro, Feltovich, Jacobson & Coulson, 1991).

The issue of learner control appears to be particularly germane in the design of hypermedia learning environments (McKnight, Dillon, & Richardson, 1996). Hypermedia represents two critical problems for designers: (1) many students may have difficulty navigating in hypermedia environments (Park & Hannafin, 1993) and (2) when given unaided access to information, students may experience difficulties locating and linking information to build meaningful cognitive structures (Hannafin et al., 1996).

Although locus of instructional control has been researched extensively, continued efforts are important due to the changing nature of control now afforded to both designers and learners. Design strategies that maximize the learning potentials of open-ended

environments, as well as learners, will likely redefine learner vs. designer controls issues into the 21st century (Hannafin et al., 1996).

One key to successful sequencing in computer-based environments is to connect to information that can be readily assimilated by the learner (McKnight, Dillon, & Richardson, 1996). Many systems, especially hypermedia systems, permit students to access parts of a lesson that may only be tangentially related. Students may link to information related in literal structure but not in contextual meaning (Gall & Hannafin, 1994; Jonassen, 1989). Following literal rather than semantic links is more likely to occur among students with limited related prior knowledge. Given control over lesson sequence, students with high domain knowledge readily connect conceptually related ideas, while students with little domain knowledge tend to connect literal definitions and examples rather than make conceptually advanced associations (Nelson & Palumbo, 1992).

Linking in hypertext/hypermedia is among the most significant capabilities that have affected design to date. These capabilities make it possible for individuals to access information in tightly controlled or open-ended manners, literally enabling lessons of unlimited variations (Hannafin et al., 1996).

Motivation and CBI

Kinzie (1990) suggested that two motivational constructs, intrinsic and continuing motivation, are important for maintaining the participation necessary to flourish in CBI environments. Intrinsic motivation describes the state that exists when individuals participate in an activity for the gratification generated by the activity itself. Continuing motivation is

evident when students choose to return to a lesson without the presence of external motivators (Seymour, Sullivan, Story & Mosley, 1987).

Keller and Suzuki (1988) adapted and elaborated a motivational model for CBI design. ARCS is an acronym that represents four categories: attention, relevance, confidence, and satisfaction. They identified three key factors: motivational objectives, learner characteristics, and learner expectations. The setting of motivational objectives is important in designing and evaluating CBI (Hannafin et al., 1996). A careful analysis of learner characteristics can help designers assess the motivational strategies needed. Malone and Lepper (1987) developed taxonomy of intrinsic motivation based on a survey of computer-game preferences among elementary school children. They classified motivation into four categories: challenge, control, curiosity, and fantasy. Few would argue with the proposition that ensuring initial motivation, maintaining interest during instruction, and encouraging continuing interest in the subject under study are as critical to the success of CBI as to any form of instruction (Hannafin et al., 1996).

Context for Learning

Context has become the cornerstone of contemporary research in areas such as situated cognition, cognitive apprenticeships, authentic learning, and anchored instruction (Brown, Collins, & Duguid, 1989; Choi & Hannafin, 1995). Cognitive processes and context are viewed as inextricably related, suggesting that knowledge is rooted fundamentally in the context in which it is acquired (Duffy & Cunningham, 1996).

Technology has played a significant role in establishing contexts for learning.

Perhaps the best-known application has been in simulations, where to-be-learned content and processes are represented in ways deemed to capture important contextual information and processes (Lewis, Stern & Linn, 1993). In studies by Dalton and Hannafin (1987) and Breuer and Kummer (1990) content was successfully embedded within, rather than disembodied from, the contexts that gave it meaning.

Cooperative Learning and CBI

Recent studies suggest that students often complete CBI as effectively, and in some cases more effectively, with a partner than alone (Repman, 1993; Repman, Rooze & Weller, 1991). Students often learn more effectively and enjoy instruction more when collaborating than when studying alone at the computer (Hooper, Temiyakarn & Williams, 1993; Hooper, 1992b; Johnson, Johnson & Stanne, 1985, 1986). Johnson and Johnson (1989) identified several important learning and social benefits associated with cooperative learning. From a cognitive perspective, cooperative learning produces higher achievement and productivity than do competitive or individualistic environments and the results are strongest for complex learning rather than for cognitively low-level learning. Many cognitive benefits can be gained by working alongside a partner: cooperative learning appears to be particularly effective for improving student achievement. Cooperative learning is designed to deepen understanding of complex lesson content through student interaction and modeling. Students working in groups are made interdependent by controlling individual and group rewards, encouraging group development, stimulating appropriate intragroup interaction, and

maintaining high personal accountability for individual and group performance (Hooper, 1992a).

Learning Environment

Technology can enhance adult learning because it has the potential to increase flexibility, provide access to expertise, facilitate discussion among learners who cannot meet face to face, reduce feelings of isolation often experienced by nontraditional learners, increase learner autonomy; and support and promote constructivist and collaborative learning (Burge, 1994; Cahoon, 1998; Eastmond, 1998; and Field, 1997). However, “technology in and of itself does not promote learning” (Burge & Roberts, 1993, p. 35), its use does not obviate the educator’s responsibility of structuring the learning to ensure these benefits result. Part of using technology effectively is understanding what adults want in the learning environment when technology is employed. Suggestions for structuring environments include the following (Burge and Carter, 1997):

1. Create a place where learners can collect important ideas, express themselves, and feel some security that they are going in the right direction
2. Provide fast and productive access to help when it is needed
3. Provide a learning environment that promotes both independent and interdependent activities with cognitive as well as psychosocial support because adults generally have two basic intrinsic motivating drives of autonomy and affiliation
4. Ensure that the learning tools are intuitive and essential for the immediate task because adults value economy of effort.

Eastmond (1998) reported that studies of adult learning through online instruction found that learners engaged in knowledge construction, collaborative learning, reflection, and interactivity. Eastmond also points out “that none of these elements are inherent in the technology but must be fostered by the course design, instructor engagement and student behavior” (p. 37). Adult educators’ primary role should be to ensure that the focus is on the learning and not the technology (Imel, 1998). “The spotlight should first fall on the conditions, dynamics, and outcomes of learner activity, in ways that promote learner self-esteem and their competence as proactive learners” (Burge & Roberts, 1993, p. 37).

Current computing environments allow for a wide range of generative learning strategies to be incorporated into courseware (Jonassen, 1988). Generative learning models suggest that meaningful learning results when the learner actively and consciously relates prior knowledge to new material and creates understandings based on these relationships (Wittrock, 1974, 1978; Wetzel, 1993). The role of instruction is to support activities and strategies that learners may use to generate meaning, and even supply mechanisms for the learner if they are unable to do their own. Generative learning requires learners to be proactive and mindful as they search for meaning by continually relating new information to what they already know. Generative activities include paraphrasing, summarizing, outlining, analytic reasoning, and mental imagery (Hannafin et al., 1996).

There is a need for the learning experience to be situated in real world contexts (Brown, Collins, & Duguid, 1989a; Resnick, 1987; Rogoff & Lave, 1984). The task is part of a larger context. The learning must be authentic to the context in which it is applied. From

this view, information cannot be remembered as independent, abstract entities. Spiro et al. (1988) argues that we must not simplify environments as we typically do in a school setting, but rather we must maintain the complexity of the environment and help the student to understand the concept embedded in the multiple complex environments in which it is found. Bednar et al. (1995) proposes an authentic environment and a complex environment referring to authenticity and complexity within a proximal range of the learner's knowledge and prior experience. The learning context must be embedded in the use of that content (Sticht & Hickey, 1991). Several researchers (Duffy, 1985, 1990; Sticht, 1975; & Mikulecky, 1982) argued that reading instruction, as well as the job knowledge, must be taught in the context of job tasks. The tasks and content combine qualitatively to provide an authentic context in which the learner can develop integrated skills.

Hypermedia Learning Environments

Hypermedia is nonlinear and presents information in graphic, sound, animation, and other forms of information transfer. Research studies in this area of CBI are in the formation stage (Thompson et al., 1993). Preliminary research indicates that the interactivity afforded by hypermedia environments may positively influence student learning. Hypermedia is an enabling environment that offers high levels of learner control, offers a new way to learn course content, and offers challenges in learning how to learn (Thompson et al., 1993).

Tennyson et al. (1984) found that programs that adapt to the learner's needs based on past performance are superior to programs that give the learner total control. Other studies

show that learner control can facilitate intrinsic motivation in students but may be sub-optimal in achieving learning outcomes (Thompson et al., 1993).

A shortcoming of hypermedia learning environments is disorientation of the student. Marchionini (1988), Heller (1990), and Morariu (1988) suggest that learners must be provided with appropriate and clear navigational and conceptual tools in order to explore the best design system, whether it is by a comprehensive index or a cognitive map. Thompson and colleagues (1993) argue that organizers and cognitive maps could provide too much structure and inhibit the discovery atmosphere of the nonlinear hypermedia environment.

Hypermedia environments can provide researchers a valuable window with which to observe student learning and learning styles. The window into these processes provided by the tracks left by a student exploring a hyper-document will be a valuable tool for the hyper-document designers and the researchers interested in understanding and defining different learning styles (Thompson et al., 1993).

The role of the computer has changed from a transmitter of knowledge to a tool that aids in the construction of knowledge (Forman & Pufall, 1988). Understanding how the processes of teaching, learning, and thinking are influenced by technologies and how these elements continue to form contexts for learning are the more complex research thrusts of the 21st century. In order to optimize technological capabilities, we need to understand better what technologies do best: process, present, store, and retrieve information and images on demand. These capabilities can be managed to engage students in thinking and learning while concurrently supporting specific teaching strategies.

CHAPTER 3 METHODOLOGY

The methodology by which a theory of effective computer-based instruction for adults was developed involved the use of Dubin's (1978) methodology for theory building and Patterson's (1986) criteria for evaluating theory. Dubin's eight-step theory building research method described in Chapter 2 is composed of two parts: theory development and research operation. This study followed all four steps of part one of Dubin's methodology for theory building which are: (1) units whose interactions constitute the subject matter of attention, (2) the laws of interaction among the units, (3) the boundaries within which the theory is expected to hold, and (4) the system states in each of which the units interact differently with each other. This study also included the first step of part two of Dubin's theory building research method: specification of the propositions of the theory. The last three steps of Dubin's methodology (part 2) that were not attempted in this research are: identifying empirical indicators of the theory, constructing the hypotheses derived from the theory, and (8) testing the theory through empirical research. Torraco (1994) refers to the last three steps of Dubin's theory building methodology as taking the theory into real world context to conduct empirical research. The purpose of this study was to develop the theory and provide a starting place for further research. A graphical depiction of Dubin's theory building research method is shown in Figure 1.

Theory Building Research Process

While Dubin's methodology includes the critical steps in constructing the theory, it

does not incorporate all the steps of a theory building research process. The process used in this study incorporates Dubin's theory and expanded on it as shown in the following overview:

1. **Concept Development** – conducted initial review of literature to understand phenomena and refined concept to formulate the study.
2. **Identification and Retrieval of Studies** - conducted expanded review of literature.
3. **Construct Analysis** - analyzed constructs and relationships from existing literature.

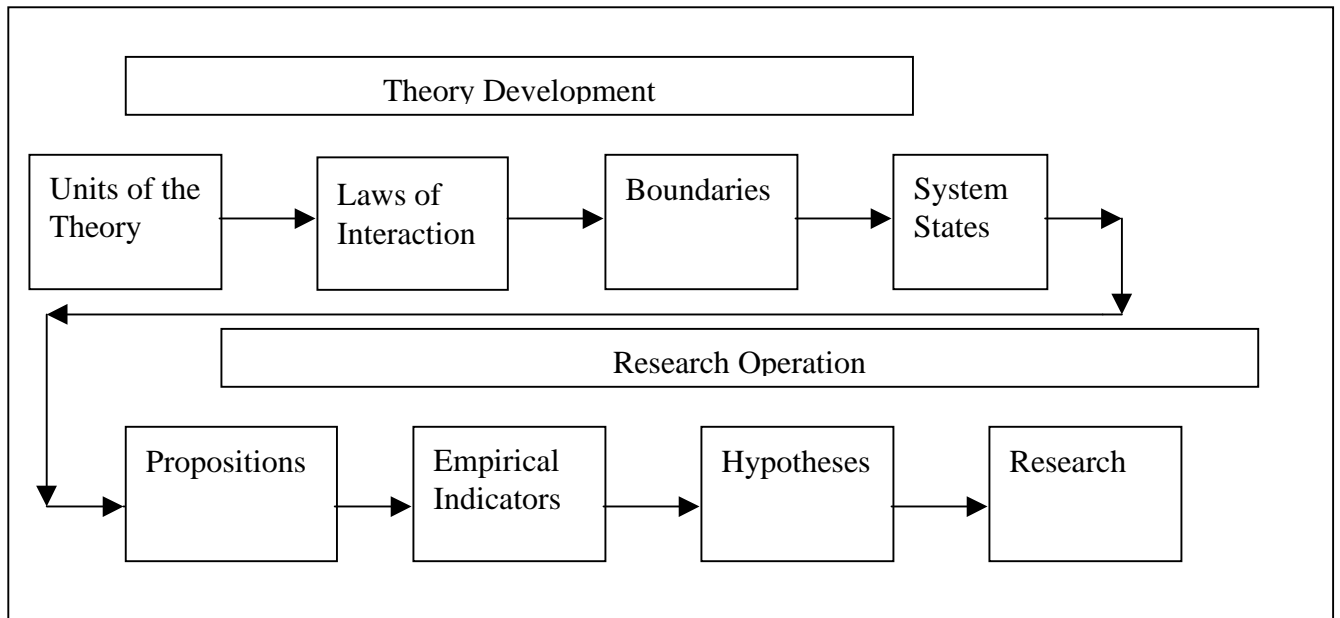


Figure 1: Dubin's Theory Building Inquiry Method

4. **Develop An Initial Theory** - developed an initial theory of effective computer-based instruction for adults by developing responses to the following five objectives:

- a. What are the units of a theory of effective computer-based instruction for adults?
 - b. What are the laws of interaction of a theory of effective computer-based instruction for adults?
 - c. What are the boundaries of a theory of effective computer-based instruction for adults?
 - d. What are the system states of a theory of effective computer-based instruction for adults?
 - e. What are the propositions of a theory of effective computer-based instruction for adults?
5. **Theory Evaluation** – theory was evaluated against Patterson’s criteria by a team of scholars. Telephone interviews were conducted using a Delphi technique to provide scholarly evaluation of “A Theory of Effective Computer-Based Instruction for Adults” based on Patterson’s criteria for evaluating theory.
6. **Analyze and Synthesize Feedback** – analyzed and synthesized feedback from scholars’ evaluations.
7. **Theory Modification** - modified the initial theory of effective computer-based instruction for adults based on synthesis of scholarly evaluation, resulting in a modified theory.

The process used in each step is described in the remaining parts of this chapter.

Concept Development

Concepts reduce the world's complexity. Designating the things about which a science tries to make sense are its concepts (Dubin, 1978). Concepts have certain characteristics associated with them and when new instances of a concept are encountered, one can draw on knowledge of associated characteristics to form assumptions and inferences about the new instance. Concepts and their labels allow individuals to think about their experiences without necessarily having to consider all their concrete, perceptual aspects. Dubin (1978) noted that there is some confusion as to the meaning of concepts, and therefore, employs the more neutral term "units" to designate the things out of which theories are built. A construct is a concept that is inferred from commonalties among observed phenomena and that can be used to explain those phenomena.

In previous research, Lowe (2002) found that many research articles on computer-based instruction addressed only one or two constructs in their research. From a more comprehensive review of different types of articles for this study, it was determined that many constructs are involved in computer-based instruction and to identify only a few did not provide a complete picture of computer-based instruction. A synthesis of the constructs was developed to provide a theory of effective computer-based instruction for adults upon which future research could be based.

Identification and Retrieval of Studies

The literature search was a vital part of the theory building process. A literature

review functions as a means of conceptualizing, justifying, implementing, and interpreting a research investigation (Merriam & Simpson, 1995). A literature review is a systematic, explicit, and reproducible method of identifying, evaluating, and interpreting the existing body of recorded work produced by researchers, scholars, and practitioners (Fink, 1998). The literature review provided a theoretical and empirical framework on which the theory of effective computer-based instruction for adults was based.

For this study, the literature search had two phases. The first phase reported in Chapter 2 helped to identify and refine the need for new theory. Phase II, described here, completed the review so a comprehensive set of constructs were analyzed. This phase began with a computerized search of various databases using WebSPIRS, InfoTrac refereed publications, and Wilson Web. The databases used in the search were ERIC, Dissertation Abstracts, and Education Full Text. These searches used computer-based instruction, computer-based training, computer-assisted instruction, web-based instruction, and web-based training as key words in the abstracts. When searches identified more than 250 sources, then additional key words adult or training were used to focus the search. From the research articles that were identified from the computerized search, the reference list of each study was perused. Research articles that were listed in the reference list and considered by the author to offer more knowledge were obtained. In order to prevent a one-sided view of the literature, the researcher reviewed articles written by researchers involved in military

training, instructional technologies, adult education, human resource development, and higher education.

All volumes of the journals listed below, from 1970-2002, located at the Louisiana State University library were searched by reviewing the table of contents. This was done to make sure that articles were not overlooked by electronic search methods. The journals searched were: *Review of Educational Research*, *Journal of Educational Research*, *Journal of Computer Based Instruction*, *Educational Technology Research and Development*, *Journal of End User Computing*, *Journal of Educational Computing Research*, *Journal of Instructional Development*, *Journal of Research on Computing in Education*, and *American Education Research Journal*.

Construct Analysis

Construct analysis focused on eliciting the basic constructs of the domain. The construct analysis allowed for the organization of the isolated findings of research into an explanatory network.

From the phase II literature review described previously in this chapter, a construct analysis table was developed to help identify the constructs used in theoretical and scholarly articles. The table in Appendix A provides a list of constructs that were found in existing research. Other theoretical literature, instructional design literature, and adult education literature were also used in determining the units that should be part of the theory. The list of constructs found in the phase II literature search served as the starting point for developing

the units of the theory. The articles were numbered as they were read by the researcher-theorist.

Develop an Initial Theory

An initial theory of effective computer-based instruction for adults was developed. The initial theory included answers to the five research questions.

In the first step of developing the initial theory, the researcher-theorist identified the units of the theory. The units present the things about which the researcher is trying to make sense and are informed by literature and the researcher's biases. The units represent the properties of things rather than the things themselves (Dubin, 1978). This step in the theory development process answered the research objective: What are the units of a theory of effective computer-based instruction for adults? To identify these units, the researcher-theorist began by determining which of the constructs from the construct analysis impacted the outcome of the studies conducted. Numerous combinations of the units were addressed to determine which led to effective CBI. Combinations of units from the construct analysis were found not to represent all the units that were needed to provide for an outcome of effective CBI. Therefore, the researcher-theorist had to consider other units that would help to make sense of the phenomenon that the theory is all about. These units were derived from other literature on instructional design, adult education, and theoretical frameworks.

The second step in developing the initial theory of effective computer-based instruction for adults was to establish the laws of interaction that govern the theory. A law of

interaction is a statement by the researcher-theorist of the relationship between units and shows how the units of the theory are linked to each other. This step in the theory development process answered the research objective: What are the laws of interaction of a theory of effective computer-based instruction for adults?

The third step in the theory development was to determine the boundaries of the theory. The boundaries of the theory establish the real-world limits or the domain of the theory. The boundaries of the theory were determined through the use of logic and indicate the domain over which the theory operates as a system. Once the boundaries of the theory were determined, then the resulting boundaries were compared against two related criteria of excellence identified by Dubin (1978) of homogeneity and generalization. The criterion of homogeneity requires that the units employed in the theory and the laws of interaction satisfy the same boundary determining criteria. The units must fit inside the boundaries before the theory is complete. The criterion of generalization of a theory relates to the domain size of the theory; therefore, the bigger the domain of the theory the more general the theory. The outcome of the third step was the determination and clarification of the two boundaries, open and closed. These boundaries make clear and explicit the real-world domain over which the theory is expected to apply. Clarification of the boundaries of the theory enabled the researcher to answer the third research objective: What are the boundaries of a theory of effective computer-based instruction for adults?

The fourth step in the theory development was to specify the system states of the theory. The system states represent conditions under which the theory is operative. Three criteria identified by Dubin (1978) when identifying the system states of a theory are inclusiveness, persistence, and distinctiveness. Inclusiveness refers to the need for all the units of the system to be included in the system states of the theory. Persistence requires that the system states persist through a meaningful period of time. Distinctiveness requires that all units take on measurable and distinctive values for the system states.

The fifth and final step in the theory development of this study was to develop the propositions of a theory of effective computer-based instruction for adults. This step was conducted after the theory evaluation and modification of the theory. The propositions were grounded in the explanatory and predictive power embedded in the theoretical framework constructed during the theory development process. The propositions of the theory are truth statements that are subject to empirical testing. Specification of the propositions of a theory of effective computer-based instruction for adults enabled the researcher to answer the last research objective: What are the propositions of a theory of effective computer-based instruction for adults?

Theory Evaluation

Evaluation of the initial theory was a critical step in the theory building process. Ultimately, without the empirical testing of a theory, theories cannot be evaluated as to their correctness or validity. The purpose of this step was to solicit external reviews as to whether

the theory met established criteria of well constructed theory, not to establish its validity.

Scholars were asked to evaluate the initial theory against criteria offered by Patterson (1986) for evaluating theory. Torracco (1994) compared Patterson's (1986) criteria for evaluating theory with five other sources of criteria (Caws, 1965; Gordon, 1968; Hage, 1972; Kaplan, 1964; and Snow, 1973) and Torracco's rationale for selecting Patterson's criteria was appropriate for this study for the following reasons:

- It was developed as criteria for evaluating theory in the behavioral sciences;
- Patterson's criteria reflects a high degree of overlap among all the criteria from the six sources reviewed;
- Patterson's criteria best represent the attributes the author seeks in a theory of effective computer-based instruction for adults.

Patterson's eight criteria for evaluating theory were used in this study with the following definitions:

1. importance – a quality or aspect of having great worth or significance; acceptance by competent professional may be indicative of importance
2. preciseness and clarity – a state of being clear; hypotheses or predictions can easily be developed from the theory
3. parsimony and simplicity – uncomplicated; minimal complexity and few assumptions
4. comprehensiveness – covering completely or broadly; covering the areas of interest

related to computer-based instruction and adults

5. operationality – precise enough to be testable and measurable
6. empirical validity or verifiability – able to be confirmed or substantiated; experiments and experience that confirm or disconfirm the theory generate new knowledge
7. fruitfulness – predictions are made that can be tested that lead to the development of new knowledge; development of new knowledge is considered fruitful
8. practicality – provides a conceptual framework for practice

Delphi Technique

A Delphi technique was used in the theory evaluation process. Strauss and Zeigler (1975) define the Delphi technique as a method for the systematic solicitation and aggregation of informed judgments from a group of experts on specific questions or issues. Strauss and Zeigler (1975) identified three types of Delphi: numeric, policy, and historic. The goal of the numeric Delphi is to specify a single or a minimum range of numeric estimates or forecasts on a problem. The goal of the policy Delphi is to define a range of answers or alternatives to a current or anticipated policy problem. The goal of the historic Delphi is to explain the range of issues that fostered a specific decision or the identification of the range of possible alternatives that could have been poised against a certain past decision.

For this study, the policy Delphi technique was used. It was the goal of this technique to establish all the differing positions advocated and the principal pro and con arguments for those positions, rather than to obtain a consensus. The theorist-researcher was looking for the pro and con arguments for the theory and not for consensus. These arguments were carefully examined to identify possible modifications to the theory.

Turoff (1970) suggests four possible objectives or secondary goals for the Delphi technique: (1) to explore or expose underlying assumptions or information leading to differing judgments; (2) to seek out information which may generate a consensus of judgment on the part of the respondent group; (3) to correlate informed judgments on a topic spanning a wide range of disciplines; and (4) to educate the respondent group as to the diverse and interrelated aspects of the topic. A Delphi exercise can encompass any one or combination of these objectives. For this study, the objective was to correlate informed judgments on a topic spanning a wide range of disciplines.

The Delphi technique can also be used as a means of soliciting interpretations, predictions, or recommendations (Strauss & Zeigler, 1975). The basic principle on which the Delphi technique operates is that several heads are better than one in making subjective conjectures about the future, and that experts make conjectures based on rational judgment rather than merely guessing (Weaver, 1971). The instrument or starting point for the Delphi technique was the evaluation form found in Appendix B. Information provided to each scholar is found in Appendix D.

Scholar Identification and Participation

Using the construct analysis table list of authors found in Appendix C, the authors/scholars were sorted in alphabetical order for first, second, third, and fourth author. From the sorting, the researcher-theorist was able to determine the number of articles that each of the authors/scholars had written. Because the objective was to include the most knowledgeable evaluators possible, it was decided to restrict the pool to the scholars that had authored at least two articles relevant to the theory. The scholars that had authored two or more articles in this phase II literature review were identified as candidates for the scholarly evaluation. The scholars that were identified are found in Table 2. Out of 34 scholars identified, current contact information was found for 26 of the scholars. These 26 scholars were sent an introduction letter asking them to participate in the evaluation of the theory. Scholars that did not respond to the first mailing were sent a second request to participate. Some scholars were sent a third request to participate.

Since scholars of CBI are not expected to be experts in the theory building process, a scholar with knowledge of Dubin's Theory Building Research Method was needed to evaluate the theory from the theory building method perspective. Also, because CBI is often promoted as self-directed learning, the knowledge of an expert in this area would add to the evaluation of the theory. Therefore, two additional scholars, one in the area of theory building and one in the area of self-directed learning, were also asked to evaluate the theory based on their knowledge in their particular area of expertise.

Table 2: Authors Based on Number of Articles in Construct Analysis

Author	Article Number	Number of Articles
M. J. Hannafin	42 & 45 & 79 & 130 & 168 & 125	6
J. D. Klein	77 & 97 & 80 & 38 & 156 & 85	6
W. M. Reed	92 & 69 & 106 & 90 & 185	5
R. H. Kay*	58 & 60 & 66 & 129	4
S. D. Stephenson	30 & 31 & 32 & 136	4
H. J. Sullivan	73 & 85 & 37 & 46	4
S. H. Gray	3 & 109 & 110	3
A. A. Koohang	34 & 61 & 59	3
D. J. Ayersman	184 & 185	2
G. P. Cartwright	13 & 55	2
A. M Crawford	26 & 121	2
S. M. Crooks	80 & 97	2
P. A. Federico*	108 & 118	2
R. S. Grabinger	161 & 191	2
I. M. Jawahar	146 & 152	2
E. E. K. Jones	46 & 80	2
G. P. Kearsley	113 & 158	2
M. B. Kinzie	10 & 183	2
G. A. Marcoulides	6 & 14	2
S. L. Massoud	5 & 64	2
G. R. Morrison	84 & 35	2
D. R. Pridemore*	38 & 77	2
C. M Reigeluth	122 & 165	2
L. P. Rieber	153 & 160	2
S. M. Ross	84 & 35	2
G. C. Sales*	57 & 164	2
D. F. Salisbury*	156 & 179	2
P. J. Schloss	13 & 55	2
H. L. Schnackenberg	37 & 46	2
H. A. Schwartz*	20 & 21	2
T. M. Shlechter*	8 & 180	2
E. R. Steinberg*	15 & 50	2
Martin Tessmer	154 & 155	2
A L. White	111 & 76	2

*No current address found

Ten scholars agreed to participate in the evaluation process. The scholars that agreed to participate in the external theory evaluation process are found in Table 3 along with a summary of their credentials. Only six of the ten actually evaluated the theory. They were Dr. David Ayersman, West Virginia University; Dr. Sharon Confessore, The George Washington University; Dr. Steven Crooks, Texas Tech University; Dr. Susan Gray, New York Institute of Technology; Dr. Greg Kearsley, consultant; and Dr. George Marcoulides, California State University, Fullerton.

Table 3: Scholars Agreeing to Evaluate A Theory of Effective Computer-Based Instruction for Adults

Name, Title, University	Notable Experience	Field of Research
David J. Ayersman Director, Instructional Technology Resource Center West Virginia University	Editor of <i>Journal of Research on Technology in Education</i> ; authored more than 25 referred publications	Individual differences, attitude toward computers, computer anxiety, performance
G. Phillip Cartwright Emeritus Professor, University of California – Davis Retired	Previously Contributing Editor and Technology Columnist for <i>Change</i> magazine	Learner control, feedback
Alice M. Crawford Sr. Lecturer, Graduate School of Business & Public Policy Navy Postgraduate School	Research Psychologist at Navy Personnel Research & Development Center; co- author <i>Distance Learning for Executives in the Military</i>	Simulation and training
Steven M. Crooks Assistant Professor, Instructional Technology Texas Tech University	Consulting Editor for <i>Educational Technology Research and Development</i> ; Reviewer for Association for Educational Communications and Technology	Instructional control, attitudes toward computers, cooperative learning

Table 3: (continued)

Name, Title, University	Notable Experience	Field of Research
Susan H. Gray Professor, Behavioral Sciences New York Institute of Technology	Combines poetry, poverty, and computers in her academic work; won 2002 Salperring Hol Press Chapbook Competition	Locus of control, sequence control
Greg P. Kearsley Independent Consultant Adjunct Professor, University of Maryland and University of Wisconsin	Course developer for Walden Institute & University of Wisconsin; CEO of Park Row Inc. (software publishing co.); developed hypertext database of instructional theories relevant to adult learning while at Army Research Institute	Human factors, individual instruction, effective CBI
George A. Marcoulides Department of Information Systems & Decision Science California State University, Fullerton	Associate Editor and member of the Review Board for the <i>Journal of Interactive Learning Research</i>	Computer anxiety, student performance
W. Michael Reed Professor & Chair, Educational Communication & Technology Program New York University	Editor of <i>Journal of Research on Technology in Education</i> ; authored more than 20 referred publications	Computer experience, individual difference, computer anxiety, attitudes
Sharon J. Confessore Assistant Professor, Human Resource Development The George Washington University	Co-Editor of <i>Guideposts to Self-Directed Learning: Expert Commentary of Essential Concepts</i> ; Principal of Human Resource Development Enterprises	Self-directed learning
Richard J. Torraco Associate Professor, Educational Administration University of Nebraska	Associate Editor and Editor Elect of <i>Human Resource Development Review</i>	Dubin's Theory Building Process

Evaluating The Theory

The scholars who evaluated the theory were sent the following information approximately two weeks before their scheduled telephone interview: (1) Chapter 4 of this study which included a draft copy of “A Theory of Effective Computer-Based Instruction for Adults,” (2) the Evaluation Package in Appendix D containing instructions for evaluation of the theory, criteria for evaluating theory based on Patterson’s eight criteria for evaluating theory, questions and a rating scale to guide the scholars during the telephone interview, and (3) the scholarly evaluation form found in Appendix B. By sending the list of questions in advance, the participants were able to become familiar with the questions and had time to reflect on the questions before the telephone interview. The scholars were asked to evaluate the theory by providing a rating and comments related to the question for the evaluation criterion. The scholars were contacted by telephone and their responses tape-recorded. It was important that all questions asked in the telephone interview with the scholars were phrased the same to ensure consistency (Dillman, 1978). The scholars also had the option to send their evaluations in writing, as well as to write on the theory itself and return to the researcher-theorist. One scholar completed the evaluation form providing a rating and comments for each criterion but did not wish to be contacted by telephone.

Analyze And Synthesize Feedback

A researcher-theorist looks for disconfirming ideas or data that constitute a signal for redoing theory. By using Patterson’s criteria for evaluating theory, the researcher-theorist

began the first step in making the theory better. Using the evaluation forms as a means of collecting the scholars' evaluation and comments, the scholarly responses were grouped by question and synthesized. For instance, each scholar's response for question one was compared and coded for consistent or inconsistent input. In conducting the syntheses and analyzing the feedback, a qualitative approach to analyzing the feedback was used. This means that the words or responses obtained were the basis of the analysis. All feedback was considered by the researcher-theorist and critically evaluated before a theory modification was made.

This step in the process required the researcher-theorist to integrate the evaluation data obtained from the scholars' feedback. Patterson's evaluation criteria (included in the questions that were asked) served as the guide. Using a synthesis approach, criticisms of the theory were divided among each of Patterson's criteria variables. Then the researcher-theorist determined which of the criticisms in each criteria variable warranted theory modification and which criticism did not, based on the strength of the argument provided by the scholars. The challenge was to make sense of the data, identify significant patterns, and construct a framework for communicating the essence of what the data revealed (Patton, 1990). There are "few agreed-on canons for qualitative data analysis, in the sense of shared ground rules for drawing conclusions and verifying their sturdiness" (Miles & Huberman, 1984, p. 16). There are no formulas for determining significance. There are no absolute rules except to do the very best with your full intellect to fairly represent the data and communicate

what the data revealed given the purpose of the study (Patton, 1990). While this theory building methodology was not a qualitative research study, these comments are appropriate to describe how the data from the evaluators was analyzed.

Theory Modification

There is no single method for modification of a theory. Theory is modified based on the evidence of research offered. Once it was determined by the researcher-theorist what modifications needed to be made to the initial theory, the modifications were made. The analysis of feedback from the scholars was used as a basis to modify the theory. A theory of effective computer-based instruction for adults is summarized in Chapter 5.

CHAPTER 4

FINDING AND RESULTS

The purpose of this chapter is to present the findings of the construct analysis based on the phase two literature review; to develop an initial theory based on those constructs; to analyze and synthesize the evaluation of the theory by scholars; and to modify the theory based on the scholarly evaluation. A summary of the final theory can be found in Chapter 5.

Identification and Retrieval of Studies

An electronic search for relevant studies in ERIC, Dissertation Abstracts International, and Education Full Text databases located articles using the following keywords: computer-based instruction, computer-based training, computer-assisted instruction, web-based instruction, and web-based training. In addition, all volumes from 1970 to 2002 of the following referred journals located in the Louisiana State University Middleton Library were searched for articles on CBI: *Review of Educational Research*, *Journal of Educational Research*, *Journal of Computer Based Instruction*, *Educational Technology Research and Development*, *Journal of End User Computing*, *Journal of Educational Computing Research*, *Journal of Instruction Development*, *Journal of Research on Computing in Education*, and *American Education Research Journal*. The articles were reviewed to determine the subjects used for the study. Subjects had to be identified as undergraduates, graduates, combination of undergraduates and graduates, or adults to be considered in the review. Studies outside the United States were not considered in this study. Articles that provided a framework, meta-analysis, or literature review related to the keywords were also included in this study. A list of the studies can be found in Appendix C.

Construct Analysis

The studies and articles were reviewed to determine the variables that were tested or included in frameworks, meta-analyses, and literature reviews. The variables that were found in the articles became the constructs and are listed in the Construct Analysis Table in Appendix A. All constructs found in these articles were considered for the theory. A summary of the constructs found in the Construct Analysis Table can be found in Table 4. Because of the number of constructs, only those found in 12 or more articles are shown in Table 4. The number 12 was chosen because the appearance of the construct in research articles dropped off sharply after this counting. These constructs were the ones most often researched. The constructs found in the summary are aptitude, attitude toward computers, computer anxiety, computer self-efficacy, support, gender, individual differences, learning styles, motivation to learn, locus of control, outcomes, feedback, instructional control, cooperative/group learning, practice activities, time, screen appearance, and computer experience. The distribution frequency in the table simply identifies which constructs were most often part of a CBI study or article.

The number of times the construct appeared in the studies did not necessarily denote its importance to the model. The constructs were the ones identified by the researcher-theorist as being most often found in research. The construct's effect on the outcome may or may not have been significant. Different configurations of the construct with other variables and treatments resulted in different outcomes and levels of significance.

Many of the constructs could be grouped together. For instance, attitude toward computers and computer anxiety help to determine computer self-efficacy. The result of the studies where gender was a construct was considered significant in the earlier studies but not

significant in the later studies. Other than the construct of outcomes, which was the dependent variable in most of the studies, attitude toward computers was the most researched variable. In the informed theory building process, the critical units of interest are not built exclusively by aggregating the variables that are already researched, but by also considering units that are not part of the construct analysis (Dubin, 1978).

Table 4: Summary of Construct Analysis

Construct	Number of Times Construct Found	Frequency
Outcomes	98	19.8%
Attitude Toward Computers	67	13.5%
Locus of Control	38	7.7%
Practice Strategy	31	6.3%
Individual Differences	27	5.5%
Instructional Control	26	5.3%
Computer Anxiety	24	4.8%
Computer Self-Efficacy	23	4.6%
Gender	23	4.6%
Motivation to Learn	20	4.0%
Computer Experience	18	3.6%
Screen Design	17	3.4%
Cooperative/Group Learning	15	3.0%
Instructional Support/Feedback	15	3.0%
Support	14	2.8%
Time	14	2.8%
Learning Styles	13	2.6%
Aptitude	12	2.4%
Total	495	100.0%

Most of the constructs previously researched were related to learner characteristics. These constructs included computer aptitude, attitudes toward computers, computer anxiety, computer self-efficacy, gender, individual differences, learning styles, motivation to learn, and locus of control. Attitude toward computers was influenced by the successfulness of the

CBI experiences. When computer anxiety was a construct in the study, there existed some level of computer anxiety for all subjects. Most likely this is due to the fact that new knowledge, no matter what the experience level with the computer, caused some anxiety. From the research, computer self-efficacy was determined to be important to learning outcomes. Computer self-efficacy helps to improve attitudes toward computers, as well as reduce the level of computer anxiety.

When analyzing the variables of gender, individual differences, and learning styles, what became apparent was the need for the subject to be able to understand and regulate their cognitive performance or to be able to recognize their metacognitive skills. Metacognitive skills are needed in the development of a self-directed learner.

Locus of control was the second most researched construct in the analysis, falling behind attitudes toward computers. Locus of control exists in adults at different levels. The adult who exhibits the internal locus of control personality trait exerts greater control of their environment, exhibits better learning, seeks new information more actively, and seems more concerned with information than with social demands of the situation. The adult who exhibits the external locus of control personality trait attributes the control of events to outside forces, are more anxious, and rely on luck rather than skill to perform tasks successfully. This personality trait is a critical component in the development of a self-directed learner.

The constructs of instructional support, instructional control, practice strategy, and screen design were found to be important in CBI design. The number of research studies in the area of CBI design was smaller compared to the amount of research found on learner characteristics. A limited amount of research on the delivery strategy of cooperative or

group learning was found. The need for adults to have support or another adult with whom to communicate was a consideration of this theory. Even though the unit of instructional strategy design was seldom found as a construct in the research, it was assumed in many studies that “good” instructional strategy design was used. Using the construct analysis as a starting point, the researcher-theorist of this study began the development of the theory.

Development of Initial Theory

After numerous iterations, a conceptual model of “A Theory of Effective Computer-Based Instruction for Adults” was developed based on the construct analysis and the second phase of the literature review. The units were identified and arrows were used to identify interactions between units. The boundaries were determined and system states developed. The theory development phase of Dubin’s theory building inquiry method was used in developing the theory. The conceptual model is found in Figure 2.

An assumption of the conceptual model is that CBI is an appropriate way to deliver the instruction. There exists a gap between what is and what should be and the intervention of computer-based instruction will fill the gap and achieve the learning goal. Several reasons that CBI may be appropriate are: (1) to guarantee consistency and standardization of information no matter what the location; (2) time constraints, as well as budget constraints for travel, that would not allow a teacher to deliver the instruction in a classroom setting; (3) CBI is available at any time that the computer is available to the learner, providing just-in-time instruction; (4) CBI allows for the accommodation of individual differences; (5) CBI allows students to review instruction until it has been mastered without risk of humiliation and group impatience; and (6) CBI allows learning under conditions of simulated risk that

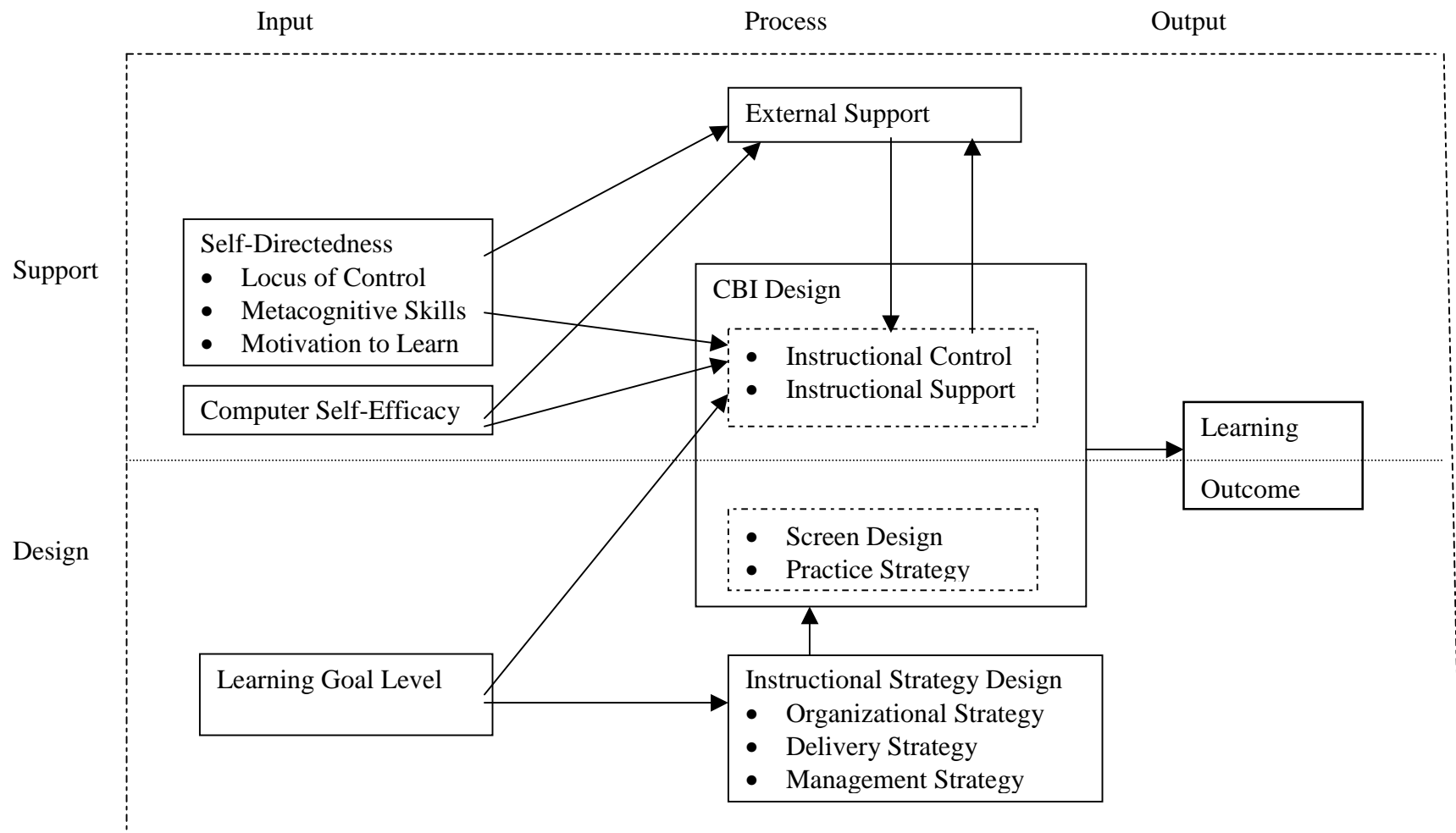


Figure 2: A Conceptual Model of Effective Computer-Based Instruction for Adults

would not be appropriate in the real world. The decision-making process for selecting CBI as the appropriate intervention is outside the boundary of this theory.

A Theory of Effective Computer-Based Instruction for Adults

A theory of effective computer-based instruction for adults integrates the critical components of computer-based instruction to provide a much-needed framework for research in CBI for adults. The researcher-theorist will begin by identifying the units of the theory, followed by a description of how these units interact, referred to as the laws of interaction. Once the laws of interaction have been presented, the limited domain of the world in which the theory is expected to hold true will be found in the boundaries of the theory. The last step in developing the theoretical framework will be the development of the system states, the state as a whole under which the theory operates. Finally, the propositions of the theory will be developed after the scholarly evaluation and theory modifications have been made to complete this study.

Units of Theory

The units of the theory are the basic building blocks from which the researcher-theorist constructs the theory (Lynham, 2002). The units represent those things whose interactions constitute the subject matter or the phenomenon of the theory (Dubin, 1978). The units of learning outcome, self-directedness, computer self-efficacy, learning goal level, instructional strategy design, CBI design, and external support represent the concepts about which the researcher is trying to make sense.

Learning Outcome

Learning outcome is defined for this study as achieving learning goal level through appropriate instruction delivered by means of a computer. Learning outcomes are the

performance made possible by learning (Wager & Gagné, 1988). The learning outcome describes what the learner is able to do when learning is completed. Students' performance or learning is assessed to determine whether the designed instruction has met its design objectives (Gagné et al., 1992). Assessment also determines whether the student has achieved the set of capabilities defined by the instructional objectives. The outcomes of learning are important in any theory of learning (Steinberg, 1991).

Gagné and colleagues (1992) provide five categories of learning outcomes: verbal information, intellectual skills, cognitive strategies, attitudes, and psychomotor skills. Gagné conjectured that the type of mental processing required for achieving outcomes in each category is qualitatively different from the mental activities required in other categories (Smith & Ragan, 1993).

Verbal information learning is analogous to Anderson's (1976) declarative knowledge, which is sometimes described as "knowing that" something is the case (Gagné, 1985). Verbal information is often designed to convey systematically organized ideas in various discourse forms such as description, exposition, and narrative. It is sometimes called declarative knowledge. It is also comparable to Bloom's (1956) levels of knowledge and comprehension. Assessing the learning of verbal information means measuring quantity (Gagné & Beard, 1978). Verbal information objectives require a learner to recall in verbatim, paraphrase, or summarize facts, lists, names, or organized information.

Intellectual skill outcome is the predominant objective of instruction and training. This kind of learning outcome enables the learner to do something that requires cognitive processing. Anderson (1976) described this type of learning as procedural knowledge. Gagné (1985) distinguished it from declarative knowledge of "knowing that" to one of

procedural knowledge of “knowing how.” Several varieties of intellectual skills are usually distinguished: discriminations, concepts, rules, and procedures or problem solving.

Assessment requires the use of a variety of intellectual skills to recognize or construct the correct answer. Intellectual skills are analogous to Bloom’s (1956) levels of application, analysis, synthesis, and evaluation.

Cognitive strategy outcome resembles a problem-solving analysis (Smith & Ragan, 1993). These outcomes influence learning across content and domains. Cognitive strategies are frequently combined with other types of learning such as intellectual skills. For this study, cognitive strategies are a part of self-directedness. Students use cognitive strategies to manage their own learning. Cognitive strategies differ from the other domains of learning because there are no specific, observable instructional outcomes in cognitive strategies. Instead, cognitive strategies are involved in whatever one is learning (Hannum, 1988). One expects that such skills will improve over a relatively long period of time as the individual engages in more and more studying, learning, and thinking (Gagné, 1992).

Attitude is an acquired internal state that influences the learner’s choice of personal action (Wager & Gagné, 1988). For an outcome of a learned or modified attitude, the change must be observable in the choices that the learner makes. In many cases, direct observation of behavior becomes infeasible and some form of self-reporting is used instead. Instruction in attitudes is often subtle and indirect. Instructional designers are hard pressed to intentionally design components into the instruction that can influence attitudes (Smith & Ragan, 1993). Attitudes are often measured by obtaining self-reports of the likelihood of actions as opposed to direct observations of the action.

Psychomotor skills are the most obvious kinds of human capacity. Although psychomotor skills have a visible muscular component, they are also dependent on a cognitive component, usually a procedural rule that organizes the kind and sequence of actions (Smith & Ragan, 1993). The sequence of actions embodied in a motor skill constitutes a procedure, which has been called the executive subroutine (Fitts & Posner, 1967). The subroutine of a motor skill is usually learned as an early part of practice and before the actual motor practice is undertaken (Wager & Gagné, 1988). Instruction may be designed to teach the rules related to motor skills; however, psychomotor skills must be physically practiced to be learned. The standards for assessment of motor skills typically refer to the precision and speed of the performance. Since motor skills are known to improve in either or both qualities with extended practice, it is unrealistic to expect that mastery can be defined in the sense of learned or not learned. Rather, a standard of performance must be decided upon to determine whether mastery has been achieved (Gagné et al., 1992).

Self-Directedness

Self-directedness is defined as an approach where learners are motivated to assume personal responsibility and collaborative control of the cognitive and contextual processes in constructing and confirming meaningful and worthwhile learning outcomes (Garrison, 1997). Self-directedness is the learner's ability to independently plan, conduct, and evaluate their learning activities (Guglielmino, 1977). The level of self-directedness is different for each learner. CBI is often referred to as self-directed learning because the learners use it at their own pace and at their own convenience with little or no human contact, and the process of learning is the responsibility of the learner. Computers can aid in promoting self-direction and efficiency (Lewis, 1990). Computer-based instruction must be designed to take different

levels of self-directedness into consideration in order to influence the learning outcome.

There are three dimensions to the self-directedness unit: motivation to learn, metacognitive skills, and locus of control.

Motivation to Learn. CBI provides individualized instruction that accounts for various learning differences of adults. One of those differences is the motivation to learn. Knowles et al. (1998) noted the fundamental differences that motivate adults to learn, known as the andragogical model. For adults, the motivation to learn is internal payoffs, the personal value they will gain in solving problems, or issues in life which promotes learning. The most potent motivators for adults are internal ones (Wlodowski, 1985). The learning that adults value the most is that which has personal value to them. Therefore, the adult must see value in the CBI in solving problems or providing internal payoffs. This motivation to learn will influence the learning outcome.

Expectancy theory (Vroom, 1995) posited that an individual's motivation is the sum of three factors: valence, instrumentality, and expectancy. Valence is the value a person places on the outcome. Instrumentality is the probability that the valued outcomes will be received given that certain outcomes have occurred. Expectancy is the belief a person has that certain effort will lead to outcomes that get rewarded. Therefore, adults will be most motivated to learn when they believe they can learn the new material (expectancy) and the learning will help them with a problem or issue (instrumentality) that is important in their life (valence).

Metacognitive Skills. Metacognitive skills are those that help a person understand and regulate cognitive performance (Artzt & Armour-Thomas, 1992; Slife & Weaver, 1992). Because of the advances made with computer technology and the research in cognitive

psychology, researchers are learning more about cognition and metacognitive skills. Adult metacognition is a multidimensional array of self-constructed, regulatory skills that span a variety of diverse cognitive domains (Schraw, 1998). Chipman and Segal (1985) described metacognition as the “deliberate and reasoned deployment of cognitive resources and strategies” (p. 7). Metacognitive skills enable the learner to know how and when to apply previously acquired knowledge or skills that are crucial to their performance in learning tasks (Flavell, 1980). The degree to which an individual is aware of these skills varies from person to person. Being able to recognize the cues and understanding how one learns will influence the learning outcome of CBI.

Metacognition distinguishes between knowledge of cognition and regulation of cognition (Baker, 1989; Schraw & Moshman, 1995). Knowledge of cognition refers to what we know about our cognition and usually includes declarative knowledge, procedural knowledge, and conditional knowledge. Declarative knowledge includes knowledge about ourselves as learners and the factors which influence our performance. Most adults know the limitations of their memory system and can plan accordingly for a task based on this knowledge. Procedural knowledge refers to knowledge about strategies and other procedures. Most adults possess a basic repertoire of useful strategies such as note taking, slowing down for important information, skimming unimportant information, using mnemonics, summarizing main ideas, and periodic self-testing. Conditional knowledge refers to knowing why and when to use a strategy. Individuals with a high degree of conditional knowledge are better able to assess the demands of a specific learning situation and in turn, select strategies that are most appropriate for that situation.

The second component of metacognition is the regulation of cognition such as planning, monitoring, and evaluation (Jacobs & Paris, 1987; Kluwe, 1987). Planning involves the selection of appropriate strategies and the allocation of resources. Monitoring includes self-testing skills to control learning. Research suggests that skilled adult learners are poor monitors under certain conditions (Koriat, 1994; Pressley & Ghatala, 1988). Evaluation refers to appraising the products and a regulatory process of one's learning. Conscious use of regulatory processes typically is related to limitations in one's ability to reflect rather than the ability to regulate (Schraw, 1998).

Locus of Control. Locus of control is a person's belief in the ability to control outcomes of forces either internal or external to themselves (Rotter, 1990). When people attribute the cause or control of events to themselves or to an external environment, this is referred to as locus of control (Spector, 1982). Internal locus of control ascribes control of events to themselves. Learners who possess internal locus of control will take responsibility for their learning with CBI, while those with external locus of control will blame the program or things external to the program for not obtaining expected learning outcomes. Providing opportunities for the learner to be in control and successful is critical to the learning outcome of CBI.

Phares (1976) noted that individuals with an internal locus of control exert greater control of their environment, exhibit better learning, seek new information more actively, and seem more concerned with information than with social demands of situations. Those that have the personality trait of external locus of control attribute the control of events to outside forces. When it comes to successfully performing a task that requires luck or skill, they will rely on luck (Kahle, 1980). This stable trait may not be easily changed.

Computer Self-Efficacy

Computer self-efficacy is defined as the individual's belief about his capabilities to successfully engage in CBI. Based on the social cognitive theory developed by Bandura (1986), self-efficacy can be defined as the belief that one has the capability to perform a particular behavior. Bandura (1993) suggests that perceived self-efficacy plays an important role in affecting motivation and behavior. Theory and research on self-efficacy suggests that in contrast to individuals with low levels of self-efficacy, the highly efficacious exert more effort, persist in the face of difficulty, and achieve higher levels of performance (Jawahar, Stone, & Cooper, 1992; Wood & Bandura, 1989). Students holding a low sense of self-efficacy for achieving a task may attempt to avoid it, whereas those who feel more efficacious may attempt it more eagerly (Bandura, 1977; Schunk, 1984).

Previous studies on computer self-efficacy determined that self-efficacy is essential in the learning and use of computers (Delcourt & Kinzie, 1993; Hill et al., 1987; Jorde-Bloom, 1988; Kinzie et al., 1994; Miura, 1987; Schunk, 1981, 1985). Geissler and Horridge (1993) suggested that the commitment to learning by using the computer would need to precede the CBI. Mehlhoff and Sisler (1989) indicated that desire to learn, or willingness to make a commitment to CBI would be a prerequisite to gaining the computer skills needed in the information age. Ertmer, Evenbeck, Cennamo, and Lehman (1994) found that the students' self-perceived confidence levels are related to their computer self-efficacy. Teacher candidates who are confident in their ability to perform computer tasks (computer self-efficacy) are also less anxious about using the computer, hold more positive attitudes toward technology and computer, were more confident in their ability to perform tasks related to teaching with technology, and used more computer coping strategies. Zhang and Espinoza

(1998) confirmed the findings of other studies (Delcourt & Kinzie, 1993; Hill et al., 1987) that students' attitudes toward computers affect their confidence levels about computers.

Learning Goal Level

A learning goal level is defined as the activities or performance required in the affective, cognitive, and/or psychomotor learning domains that results in the desired outcome of learning (Gagné et al., 1992). To determine if the learning outcome is attained, the learning goal level must be a part of the theory (Steinberg, 1991). There are three domains of behavioral learning: affective, cognitive and psychomotor. Learning goal level is demonstrated using Bloom's Taxonomy of Educational Objectives in the Affective and Cognitive Domains (1956) and Dave's Taxonomy of the Psychomotor Domain (1970).

Bloom's Taxonomy of the Affective Domain consists of five levels, each behavior building on the previous behavior level. The affective domain includes the manner in which one deals with things emotionally such as feelings, values, appreciations, enthusiasms, motivations, and attitudes. The first level in the affective domain is receiving. This level is concerned with the learner's sensitivity to the existence of certain phenomena and stimuli and the learner's willingness to receive or attend to them. The second level of the affective domain is responding. Responding indicates that the learner has become sufficiently involved in or committed to a subject, phenomenon, or activity that he or she seeks out and gains satisfaction from working with it or engaging in it. The third level of the affective domain is valuing. This behavior is sufficiently consistent and stable and takes on the characteristics of a belief or an attitude. Many adults change their attitudes toward computers based on the value of the computer to them. The fourth level in the affective domain is organizing. As learners internalize values, they encounter situations where more

than one value is relevant. Krathwohl et al. (1964) suggests that this is the level at which value systems are developed. The final level of the affective domain is characterizing. At this level of internalization, the individual's value hierarchy is organized into an internally consistent system. This behavior is consistent with the values internalized and when the individual is threatened or challenged the behavior arouses emotion.

Bloom's Taxonomy of the Cognitive Domain consists of six levels, each building on the previous. The cognitive domain involves knowledge and the development of intellectual skills. The first and simplest level is knowledge, defined by Bloom as recognition and recall of facts and specifics. The second goal level is comprehension, which requires knowledge. Bloom defines comprehension as being able to interpret, translate, summarize, or paraphrase given information. The third goal level in the cognitive domain is application, which requires comprehension of information in order to apply in new situations. Application is defined as using information in a situation different from the original learning context. Analysis is the fourth goal level and is defined as the ability to separate the whole into its parts until relationships among the elements are clear. Analysis requires the ability to apply information in order to analyze. Synthesis is the fifth goal level in Bloom's Taxonomy and is defined as the ability to combine elements to form a new entity from the original one. Like the other goal levels before it, this level requires analysis in order to synthesize. The last goal level of Bloom's Taxonomy is evaluation. Evaluation involves acts of decision-making, judging, or selecting based on criteria and rationale. To complete the last step in the taxonomy, one must possess each of these cognitive skills.

Several taxonomies for the psychomotor domain exist (Harrow, 1972; Simpson, 1972), but in this study Dave's (1970) Taxonomy of Psychomotor Domain was used. Dave's

Taxonomy of Educational Objectives in the Psychomotor Domain consists of five levels: imitation, manipulation, precision, articulation, and naturalization. The psychomotor domain includes physical movement, coordination, and use of the motor-skill areas. Development of these skills requires practice and is measured in execution terms of speed, precision, distance, procedures, or techniques. Imitation is the first level of the taxonomy and includes repeating an act that has been demonstrated or explained. It includes trial and error until an appropriate response is achieved.

Manipulation is the second level of psychomotor domain and consists of continued practice of a skill or sequence until it becomes habitual and the action can be performed with confidence and proficiency. Precision is the third level of the taxonomy and denotes that the skill has been attained with accuracy, proportion, and exactness. The fourth level of the psychomotor domain, articulation, requires a higher level of precision. The skills are well developed and can be modified to fit new situations or combined with other skills in sequence with harmony and consistency. The last level of the psychomotor domain taxonomy is naturalization. Naturalization occurs when the response is automatic but with limited physical or mental exertion.

For CBI, most of the research has been in the cognitive domain. Lewis (1990) suggested that the learning goal level of knowledge can be accomplished through the CBI modes of drill and practice, tutorial or simulation. Tutorial programs are used to teach new skills and provide new knowledge (Wager & Gagné, 1988). Drill and practice programs are used to strengthen learned associations and build skill in concept classification and rule usage. Simulation is a representation of reality. Learning from simulation is trial and error or a discovery learning process.

The learning goal level of comprehension is best accomplished through the CBI modes of tutorial and simulation or through drill and practice. The learning goal level of application is best accomplished through the CBI mode of simulation and tutorial. The learning goal levels of analysis and synthesis are best accomplished through the CBI mode of simulation. Finally, the learning goal level of evaluation can be obtained through the CBI mode of simulation. The quality of the program may determine the learning goal achieved. The modes of CBI may be appropriate for any of the three learning domains; however, in most cases the cognitive domain is most often referenced. The lower cognitive learning goal levels are often a prerequisite to the affective and psychomotor learning goal levels.

Federico (1982) suggested that no method of instruction produces identical instructional outcomes in all students, not even computer-managed mastery learning. The real challenge facing educational technologists is to consider the goals of instruction and adjust the strategies, models, and tactics to attune the nature of the task to the perspective of the student (Jonassen, 1994). Jawahar and Elango (2001) suggested that specific, challenging goals should be set in respect to learning and transfer.

Instructional Strategy Design

Instructional strategy design is defined as elemental methods for determining and sequencing content, presenting content and decision-making related to the content and its delivery. Janniro (1993) found CBI to be most effective when systematically developed and course content follows the principles of teaching. Steinberg (1991) suggested that appropriate computer application means the application of sound instructional principles. The design of learning materials and environment is the core of educational technology (Kozma, 2000). Tennyson and Foshay (2000) included the following activities in the

instructional design process: analyzing the information, identifying entry knowledge and behaviors, determining the organization and sequencing of information, specifying the instructional strategies, message design, and human factors. Reigeluth (1983) classified the components of instructional strategy design unit into three types: organizational strategy, delivery strategy, and management strategy.

Organizational Strategy. Organizational strategy is the method of sequencing the subject matter content for instruction. Gagné and Briggs' (1979) events of instruction should be included in the organizational strategy of the lesson or learning module. Sequencing of information within a module of CBI would be determined by the objectives. For those objectives in the declarative and procedural areas, the information would be sequenced by applying principles from the learning theory in use. For higher-order objectives, the sequence is based on an interaction with the learner and information (Tennyson & Foshay, 2000).

Bunderson and Inouye (1987) proposed that when designing instruction, the information can be analyzed to determine the most efficient arrangement of the knowledge for purposes of learning, not for purposes of disciplined organization. Learning gains related to lesson organization may ultimately relate to the total available mental processing capacity of the learner (Clariana, 1993). Well-organized information serves as a graphic organizer, helps in learning the information, and provides an external map-like organizer for guiding the acquisition of unfamiliar material (Dean & Kulhavy, 1981). This map links incoming information to preexisting knowledge, processed at a deeper level of encoding, resulting in associative learning (Anderson & Archer, 1970; Craig & Lockhart, 1972; Foss & Harwood, 1975; Rothkopf & Coke, 1968). Organized content increase the efficiency of searches

(Christie & Just, 1976). Older or high-ability learners with more remembering or thinking capacity may be more likely to benefit from organization. Shute and Gluck (1996) found that a higher level of education and interest in the content of the instruction were the two key factors associated with more exploratory behavior and with higher posttest achievement.

Delivery Strategy. Delivery strategies normally involve determining the appropriate media of instruction and grouping strategies. Because the need for CBI was determined previously, one only needs to address the grouping strategy for instruction. The instructional delivery strategy for CBI could be individual, dyad, or small group consisting of three students. Stephenson (1991) suggested that low achievers benefit from having another human around who is aware of actions that alter the learning behavior. Carrier and Sales (1987) found that students working in pairs with CBI provided an opportunity for the students to check out understanding of concepts with their partner.

Management Strategy. The instructional management strategy guides the orchestration of organizational and delivery strategies (Smith & Ragan, 1993). Scheduling of instruction and the mechanisms for delivery of instruction are guided by the management strategy. With CBI, scheduling may include providing times when a computer room is available or using resources to ensure that enough computers are available for those needing CBI. This strategy also includes the management of instruction for individuals, which provides diagnosis, prescriptions, status reports, and test scores for each individual in the CBI program. Management strategies involve the use of resources and managing individualized instruction.

CBI Design

CBI design is defined as the programming of content and lesson design that considers the individual differences of the learner to achieve the learning goal level delivered by computer. Critical for promoting achievement in CBI are features that provide opportunities for problem solving, corrective feedback, elaboration, visual and graphic cues, control of the routine by the learner, and appropriate wait time between input and response (Lewis, 1990). This unit of the model makes CBI different from other forms of individualized instruction. CBI design is comprised of four components: instructional control, instructional support, screen design, and practice strategy.

Instructional Control. Instructional control can be program controlled where the program guides the learner; learner controlled where the learner determines the options; or adaptive controlled that is a combination of program and learner controlled where control is based on the learner's responses. CBI that is adaptive or intelligent to student's responses and rate of learning is twice as effective (Gibbons & Fairweather, 2000). Gibbons and Fairweather (2000) believed that this instructional approach is a potent effectiveness factor in CBI. Numerous researchers have found that learner control in CBI positively influences retention of information and increases test performance (Hansen, 1974; Kinzie, Sullivan, & Berdel, 1988; Newkirk, 1973; Ross & Morrison, 1989; Schloss, Wisniewski, & Cartwright, 1988; Steinberg, Baskin, & Hofer, 1986). Several researchers have found positive achievement results from giving learners control over elements of their instruction such as amount of contextual support (Ross, Morrison, & O'Dell, 1989; Shaw, 1992), amount of information and practice (Hannafin & Sullivan, 1995), amount of review (Kinzie, Sullivan, & Berdel, 1988), and sequencing of the instruction (Gray, 1987). Gray (1989) concluded that

CBI for single class sessions and directed at students with little background in the subject matter will be effective with minimum user control over the sequencing of instructional content.

Instructional Support. Supporting the adult learner during the CBI learning process is important to the learning outcome of CBI. Weiss (1985) noted that the more a CBI program must “stand alone,” through lack of instructional support, the greater the burden on the instructional content to be clear, and on documentation and guides to explain how to use the CBI program. Instructional support enhances the understanding of the content of instruction by specific examples, glossary, procedures, help, hints, feedback, and coaching. When learners perceive instruction to be difficult, they seek out more instructional support (Tobias, 1982) such as elaborate feedback.

Feedback is one form of instructional support that influences the learning process by motivating the learner and/or by providing additional information about the task (Sales & Williams, 1988; Steinberg, 1991). Feedback is the evaluative or corrective information about an action, choice or inquiry that the learner has made within the instructional program. Clariana (1993) found that the more information provided by feedback, the better the performance. Feedback has to be valued by the learner to be motivating. Feedback can motivate students by encouraging them when learning is difficult (Steinberg, 1991). Kulhavy and Stock (1989) referred to feedback as a unit of information with two components, verification and elaboration. Pridemore and Klein (1991) found that students who received elaboration feedback during instruction performed better than students who received verification feedback, and suggested that different feedback messages be provided based on the student responses. Verification feedback could be provided to students when their initial

response is correct and elaborate feedback provided when an initial response is incorrect. Students who received verification feedback indicated a desire to have more feedback during instruction.

Screen Design. Screen design research indicates that displaying information at a consistent location or relevant to graphical information facilitates learning (Aspillaga, 1991). The enriched screen-control capabilities of computers provide displays that more clearly represent information in meaningful contexts (Tennyson & Foshay, 2000). Good screen design can have an important motivating role because it maintains the attention and interest of the student (Steinberg, 1991). Spatial location aids learning by providing encoding links to existing information (Belezza, 1983; Christies & Just, 1976; Cross, 1974; Gagné, 1977; Roger & Cable, 1976; Rothkopf & Coke, 1968). Location as a cue is only helpful by its association with the content (Foss & Harwood, 1975), for it works as a mediator between content and visual material (Christie & Just, 1976; Zechmeister & McKillip, 1972). Layout has been shown to enhance transfer of information providing a second choice for the learner in arrangement of content through location (Aspillaga, 1991). CBI designers can improve learning by integrating instructional visuals designed using information-processing learning theories, and including screen design strategies to enhance the transfer of information (Janniro, 1993). CBI designers should continue to create innovative visuals that help students remember facts and relationships and grasp the overall concepts of the lesson.

Computer presentation of text can facilitate learning by providing focus. Gillingham's (1988) review of research suggested three aspects of structure and organization that affect learning and remembering. They are superordination, topic relatedness, and cohesion. A superordinate sentence explicitly states the main idea of the accompanying text. Research

indicates that adults learn the top-level or superordinate ideas of text first and filter out peripheral information (Steinberg, 1991). They are less likely to forget superordinate information (Meyer, 1977; 1985). Research with technical prose also reveals the importance of stating the main idea, and stating it first (Kieras, 1982). Topic relatedness refers to the idea that text is expected to be on a single topic. This is particularly important in technical prose (Steinberg, 1991). Cohesion is the connectedness of prose. Prose is most readily learned and remembered when writers follow some sort of plan and signal this plan to the reader (Meyer, 1977). The implication for CBI is that it is counterproductive to display text one sentence at a time because it may interfere with understanding the relatedness of the text (Steinberg, 1991).

Graphics represent important capabilities for CBI in terms of encouraging intuition or insight about the relationship between concepts (Bork, 1977; Kearsley & Hillelsohn, 1982). Graphics have value in illustrating processes students cannot see and increasing active participation in the instruction (Lahey, Crawford, & Hurlock, 1975; Trollip, 1979). Reeder, Charney, and Morgan (1986) found that elaborated text was advantageous for learning complex procedural skills. Ross, Morrison, and O'Dell (1988) found that low-density presentations reduced lesson length and reading time without adversely affecting learning of important facts and concepts.

Practice Strategy. The appropriate amount of information and practice to include in CBI varies by the difficulty of the subject-matter and individual learner characteristics. When faced with the decision of determining the amount of practice to include in CBI, a greater amount of practice should be provided if higher student achievement is an important goal of the instruction (Schnackenberg et al., 1998).

Fitts and Posner (1967) identified the stages of skill learning as: cognitive stage, associative stage, and autonomous stage. Cognitive stage of skill learning begins with an instructional or overview phase in which the learner receives or studies information or instruction about the skill. The learner typically gives a verbal description of how the skill is performed and states the basic facts associated with the skill. In the associative stage of skill learning, the learner attempts to perform the skill based on the knowledge acquired in the cognitive stage. In this stage the errors or inadequacies are corrected. In the autonomous stage of skill acquisition, the performance of the skill becomes automatic and rapid. Not all skills reach the autonomous stage. Automaticity is a necessity for more complex, higher level skill (Smith & Ragan, 1993).

Salisbury (1988) provided the following overview of the three stages of skill acquisition and the important role of practice in the learning process. Practice during the cognitive stage usually involves the learning of factual information, which is a prerequisite to performing the final skill. During the associative stage, practice assists the learner in performing the skill smoothly and accurately. The learner may have to use considerable of mental concentration to perform the skill. During the autonomous stage, practice allows the learner to perform the skill without much mental concentration so that the learner's attention capacity is available to devote to other aspects of the task. Many skills must be performed at the autonomous stage to be useful.

Schnackenberg et al. (1998) found that students practiced more in their instructional program scored higher on the posttest than those that had a lesser amount of practice. Students preferred more practice and information in abstract or hypothetical learning situations than students working through a program in a real instructional setting.

Marcoulides (1990) found that students who are “spoon-fed” sets of rules for choosing and using statistical procedures without hands-on practice in concrete examples tended to misapply or forget the rules. Students need hands-on examples to help visualize the operational procedures.

External Support

External support is defined as providing for the needs of the learner with support external to the CBI program but is required to promote the learning outcome of CBI. External support should provide appropriate computer equipment, technical support, time for the learner to participate in CBI, and support from peers, supervisors, facilitator, management, friends, and family. Tough (1967, 1979) repeatedly highlighted the strong reliance on external resources, both human and material, in the conduct of learning projects and noted that adults would like more assistance in their learning pursuits.

The necessity of considering the learning environment and its support systems has been widely recognized in education and instructional design (Tessmer, 1990). Environment analysis may be recognized as important to the success of an instructional project, but it is rarely completed as a major stage or factor in the instructional design process. Instruction may embody the proper outcomes and strategies but lack the means to be thoroughly or successfully utilized in its intended environments. Tessmer (1990) suggested two factors that should be considered in the environmental analysis: physical and use factors. Each of these two factors is further divided into instructional environment and support environment. The physical factors of the instructional environment are facilities, instructional lifespan, and equipment. In the case of the psychomotor domain, the instructional environment must provide for development of the motor skills. The use factors of the instructional environment

are patterns of use, reasons for use, student-user characteristics, and administrator characteristics. The support environment is the system in which the instructional environment is embedded, the system that administers, facilitates, and supports instructional activities. The physical factors of the support environment are site distribution, management and coordination, and seasons and climate. These factors are part of the instructional strategy design. The use factors of the support environment are production services, storage and delivery services, dissemination considerations, and support resources. For this study, external support factors are those in the learning environment that are not addressed elsewhere in the model.

Research in external support is limited, but several researchers found it important in accomplishment of the learning outcome of CBI. Peters and O'Connor (1980; Peters, O'Connor, & Eulberg, 1985) reported that situational constraints interfere with or restrict an individual's performance. Mathieu et al. (1992, 1993) found that trainees' foreknowledge of constraints reduces their motivation to perform well in training or instruction. Jawahar (2002) referred to these situational constraints as complexity of training, time, and software user-friendliness that restrict the range of individual performance. Mathieu and Martineau (1998) referred to the situational constraints as adequacy of job-related information, tools and equipment, materials and supplies, financial and budgetary support, and time availability. If there are severe constraints in a given setting, performance is less a function of individual differences and more a function of situational factors, and less predictable from measures of theoretically-relevant individual differences. Stephenson (1991) found that the instructor /facilitator interaction with the student increased his or her achievement. Jawahar (2002) found that the perception of the situational constraints negatively influenced end user

performance. Providing support for the computer system and its users increased employees' outcome expectancy and ultimately organizational commitment (Stone & Henry, 2003).

Laws of Interaction

A law of interaction is a statement by the researcher-theorist of the relationship between units and shows how the units of the theory are linked. In this section, the laws of interaction of “A Theory of Effective Computer-Based Instruction for Adults” are developed. To provide for the output of learning outcome, the CBI design unit interacts with the other units of the model: self-directedness, computer self-efficacy, external support, instructional strategy design, and learning goal level

In the conceptual model in Figure 2, the units of the model were arranged into two distinct horizontal halves of the model, the top half of support and the bottom half of design. The units of the support half are external support, self-directedness, computer self-efficacy and the components of instructional control and instructional support of CBI design. The units of the design half are learning goal level, instructional strategy design, and the components of screen design and practice strategy of CBI design. The learning goal level influences both the support and design halves of the model.

Self-Directedness and CBI Design

Self-directedness is expected to influence the components of instructional control and instructional support of the unit domain of CBI design. Learners who possess internal locus of control, high metacognitive skills, and a high level of motivation to learn will be successful using learner controlled options for CBI design and less instructional support. Learners who possess external locus of control, low metacognitive skills, and low level of motivation to learn will need program control for instruction and much instructional support.

Instructional support through feedback will improve motivation. Learners with low metacognitive skills will need more program control to assure that the learner receives all the information for the learning outcome. Learners who possess a continuum of these self-directedness characteristics and the components of instructional control and instructional support will need to be considerate of these differences.

Learner control may be unsuccessful for some subjects because they lack metacognitive skills (Allen & Merrill, 1985; Rigney, 1978) or lack information they need about the learning progress to make meaningful decisions about how to manage learning (Tennyson & Rothen, 1979). Holden (1995) found that higher self-directed learning readiness participants had higher achievement than lower level participants and lower level self-directed learning readiness participants with program control had higher achievement than participants with learner control. Grow (1991) identified four stages of self-directed learning and the teaching style associated with each. The four stages of self-directedness were: stage 1 is the dependent learner with the teaching style of authority and coach; stage 2 is the interested learner with the teaching style of motivator and guide; stage 3 is the involved learner with the teaching style of facilitator; and stage 4 is the self-directed learner with the teaching style of consultant or delegator. The most severe problems occur when dependent learners are mismatched with the non-directive teaching styles, and when self-directed learners are mismatched with the directive teaching style. Most adults are not self-directed and need to transition to a self-directed learner (Grow, 1991). CBI should help students move from stage 1 of dependent learner to stage 4 of the self-directed learner over their lifelong learning process.

Kinzie (1990) proposed a framework that demonstrated an interdependence and mutual importance of learner control and self-regulated learning and continuing motivation. The exercise of learner control is a precursor to the development of self-regulation. Learners who command the greatest range and depth of learning skills will be the best equipped to handle learner control and other forms of instructional self-management (Resnick, 1972). When learner control in an interactive system is exercised, the benefits are reflected in increased student self-regulation and continuing motivation. Similarly, when interactive systems stimulate student motivation, students' excitement and interest in learning can positively influence their desire to exercise control and manage their own learning (Kinzie, 1990).

Gray (1989) found that more program control of the sequencing of instruction the better the performance. Students that showed higher external locus of control and were given learner control of sequencing of instruction performed poorly. However, students that showed higher internal locus of control and were provided some control over the sequencing performed the best. Gray (1989) found that CBI is more effective when sequencing is program controlled and learners control the review. The less familiar learners are with the content, the greater the need for instructional supportive structure. Program control of the order of presented topics can be viewed as a form of supportive structure analogous to clearly stated objective and other guidance devices. Gray (1989) recommends that instruction or informational retrieval application mold their structure to the external locus of control learners who will be less skilled in finding and using information. Instructional programs that are meant for single class sessions and directed at students with little prior background in

the subject matter will be more effective with minimum user control over the sequencing of instruction (Gray, 1989).

If the learner possesses the attribute of internal locus of control, to take some control over the learning is important to that learner (Hannafin, 1984). Learner control strategies should include coaching to assist learners in making informed decisions (Ross, 1984; Tennyson & Buttrey, 1980). Failure to provide guidance can prove frustrating to learners as they may be unable to make intelligent informed choices. Numerous researchers have found that learner control in CBI positively influenced retention of information and increased test performance (Hansen, 1974; Kinzie, Sullivan, & Berdel, 1988; Newkirk, 1973; Ross & Morrison, 1989; Schloss, Wisniewski, & Cartwright, 1988; Steinberg, Baskin, & Hofer, 1986). Therefore, learners with internal locus of control may need to be able to control some of the practice and review activities. Santiago and Okey (1992) suggested that the instructional designers should determine what role CBI could play in effecting shifts in learners from external locus of control to internal locus of control.

For some subjects, learner control may be unsuccessful because they lack the metacognitive skills (Allen & Merrill, 1985; Rigney, 1978) or lack the information they need about their learning progress to make meaningful decisions about how to manage learning (Tennyson & Rothen, 1979). Motivation, as well as cognition, influences learner control (Steinberg, 1991).

Another reason for using learner control is that it helps students become independent learners and develop their self-efficacy and self-determination (Kinzie, 1990; Snow, 1980). Mager (1964) and Merrill (1975) contended that learners know their own instructional needs best and are uniquely qualified to tailor instruction to meet those needs. From the

constructivist viewpoint, learners construct their own knowledge, and yielding some control over instruction to the learner enables them to construct knowledge in the context of their own needs and experience (Jonassen, 1991).

A fundamental issue in planning instruction is how much instructional support to provide to the student at any particular moment in the learning process (Allen & Merrill, 1985). Using Bovy's (1981) model for matching intervention with cognitive skills, Allen and Merrill (1985) suggested that low cognitive skills require more instructional support and high cognitive skills require less instructional support, since the learner has his own internalized knowledge about how to learn.

Sales and Carrier (1987) found that students selected elaborative feedback when given the opportunity to select from a continuum of choices ranging from no feedback to information-dense screens. Learner control of feedback selection resulted in students asking for knowledge of correct responses or elaborate feedback more frequently than simple knowledge of results feedback (Sales & Williams, 1988). The capacity to provide different levels of feedback within a single instructional lesson is an attribute associated with the computer. These different levels of feedback should be tailored to match the needs of the learners as well as the desired learning outcomes (Sales, 1988). Individual learner characteristics can be associated with types and amounts of instructional support. For CBI to be effective, students' interest must be aroused and maintained (Sales & Williams, 1988). Accommodating individual needs and preferences related to instructional support may help to accomplish this goal.

Computer Self-Efficacy and CBI Design

Computer self-efficacy is expected to influence the components of instructional control and instructional support of the unit domain of CBI design. Learners with low computer self-efficacy must be given the opportunity to be successful. Only through experience and success with CBI will the computer self-efficacy level rise. Instructional support such as feedback and coaching needs to be available to the learner to enable them to be successful. An adaptive instructional control program would allow the learner to increase their level of computer self-efficacy, as they are successful with CBI. Learner control is more appropriate for the learner with high computer self-efficacy.

Olivier and Shapiro (1993) found that those who possess a high degree of self-efficacy tend to be higher achievers than those who have a lower degree of self-efficacy. Low self-efficacy reflects a lack of confidence in the ability to manipulate the system to achieve desired results (Hill & Hannafin, 1997). Consequently, users are more likely to accept rather than question system-generated information or program controlled design. High self-efficacy users tend to be more persistent in their search and more confident in their ability to locate the resources they seek (Murphy, 1988), so learner control may be more appropriate as the instructional control. Gist, Schowerer, and Rosen (1989) found that vicarious experiences with the computer increased one's feelings of control and confidence. Hattie (1990) suggested that the higher perceived controllability of the computer by the individual, the higher his/her perceived self-efficacy is to maintain that control. There is evidence that giving learners partial control over elements of instruction yields more favorable attitudes toward CBI and produce relatively high learner achievement (Schnakerber et al., 1998; Crooks et al., 1996). Leso and Peck (1992) found that students may encounter

less frustration and gain more confidence when they attempt and accomplish relatively simpler tasks and receive immediate feedback regarding their success with software application. Ertmer et al. (1994) found that to enhance the effect of the learning experience on students' efficacy through situating those experiences within a learning context that provides an acceptable means for voicing frustration and receiving encouraging feedback regarding one's developing skills was most important. Jawahar and Elango (2001) found that enhancing the motivation of end users is one avenue to increase end user performance where attitudes toward working with computers, goal setting, and computer self-efficacy address motivation of end users.

Self-Directedness and External Support

Self-directedness is expected to influence the unit of external support. The higher the level of self-directedness of the learner, the less external support is required. For instance, the learners who possess internal locus of control, high metacognitive skills, and high motivation to learn require less external support. Learners who possess external locus of control will need more external support since they believe that performance is a result of the external events or environments. Low motivation to learn can be promoted through external support. Management's encouragement and support could be of great importance to the learner with low motivation to learn. Dependent learners want close supervision, immediate feedback, frequent interaction, constant motivation and continuous direction (Grow, 1991). External support can provide many of these elements for the dependent learner. As the learner becomes more self-directed, less external support is required. Steinberg (1991) suggested two factors that influence the likelihood of students completing a CBI course are

personal contacts with instructors and students' self-discipline. A student must have the opportunity to complete the course for it to be effective.

Research supports the claim that enhancing motivation of end users to learn and effectively use end user computing skills is crucial to end user computing (Bostrom, Olfman, & Sein, 1990; Jawahar, 2002; Jawahar & Elango, 2001; Sein, Bostrom, & Olfman, 1987). Jawahar (2002) found managers can positively influence employees' attitudes toward using CBI by communicating how the knowledge can enhance their productivity. Jawahar (2002) also found that goal setting had the most effect on end user performance. Kopelman, Brief, and Guzzo (1990) suggested that having sufficient supplies, materials, equipment, services and resources necessary to perform one's job would yield higher employee motivation, whereas lack of the same would create frustration. The researcher-theorist suggests that it is also true with CBI.

Computer Self-Efficacy and External Support

Computer self-efficacy is expected to influence the unit of external support. Learners who have a high level of computer self-efficacy require less external support than those with a low level of computer self-efficacy. Learners with high levels of computer self-efficacy will take it upon themselves to find the external support that is needed. However, learners with low computer self-efficacy will look to external support to facilitate learning. The low computer self-efficacy learner will need technical support, time from work to participate, and encouraging words from management to help raise their level of computer self-efficacy.

Stone and Henry (2003) found that links between organizational commitment and computer self-efficacy and outcome expectancy are consistent with results reported in the literature. Their model linked past computer experience, computer staff support, system ease

of use and the degree of system use to the end-user's sense of computer self-efficacy, outcome expectancy, and ultimately organizational commitment. Jawahar (2002) found that situational factors such as insufficient or faulty equipment, lack of resources, and time constraints adversely affects performance, and reduces the ability of individual differences to predict performance. Jawahar (2002) also found that attitudes toward working with computers, goal setting, and self-efficacy were positively related to end user performance.

Jawahar and Elango (2001) found managers could increase end user performance by enhancing end users' self-efficacy beliefs. Bandura (1982) suggested self-efficacy beliefs can be enhanced through performance accomplishments, vicarious experiences, verbal persuasion and emotional arousal. Jorde-Bloom (1988) found that organizational components and environmental considerations served as powerful motivators in determining computer-related behavior. Individuals who exhibit a low self-efficacy with technological innovations are more apt to be resistant to them (Hill, Smith & Mann, 1987). An individual's feelings of self-efficacy regulates the degree of commitment that the individual is willing to invest in learning about CBI. Ertmer and colleagues (1994) found it possible to enhance the effect of the CBI experience on students' efficacy judgments by situating those experiences within a learning context which provides a means for voicing frustration and for receiving encouraging feedback. Therefore, creating a non-threatening environment or, in this case, providing an external support would significantly influence the individual's level of commitment to CBI.

External Support and CBI Design

External support and CBI design are expected to interrelate. Strong external support can be incorporated in CBI design-support. Strong external support will offset weak CBI

design. If CBI design is a strong design that allows for the individual differences in the learner, external support can be at a minimum. However, if CBI design is weak and does not provide for the individual differences of the learner, external support must be strong. CBI design may take into account the individual differences, but some of those differences will require external support.

External support should provide for motor skill practice when the CBI design is influenced by the learning goal level of the psychomotor domain. Jawahar (2002) found that providing time to practice newly acquired computer skills is one way of providing external support by managers for CBI. Shlechter (1990) found that students who received CBI in a group presentation completed the instruction with increased efficiency and less external support (proctor assistance). Stephenson (1992) found that in pairs of learners with little experience on spreadsheet software, the dyad partner provided the feedback, support, and social facilitation typically provided by the instructor in a traditional classroom.

Instructional Strategy Design and CBI Design

Instructional strategy design precedes the components of screen design and practice of the unit domain of CBI design. The instructional strategy design unit influences the screen design based on the organization of the information and the practice strategy based on the level of learning goal to be accomplished. Strong instructional strategy design should influence the CBI design related to appropriate screen design and type of practice. Weak instructional strategy design will result in poor CBI design.

The organizational strategy of the instruction influences the screen design. How the instruction is sequenced, the location of the content on the screen, and how the content is displayed impacts the learning process of the adult. Computer presentation of text can

facilitate learning by providing focus (Steinberg, 1991). This occurs when the computer lesson is presented in limited amounts of text on the screen and the learner presses a key to continue reading the text at his own pace. Gillingham (1988) found that program control of the rate of presenting text is not a useful approach. Ross, Morrison, and O'Dell (1988) suggested the use of low-density text as a standard feature or learner-control option for CBI.

If an instructional path has been deemed to be the most effective, it should be provided to both program and learner controlled options. The learner controlled option should not prevent the learner from having the most effective instructional path available (Hannafin, 1984). Structural guidance, such as the event of instruction, should be provided regardless of the instructional control.

Practice provides for the learner's active participation in the learning process and assesses how learning is progressing so that remediation may be provided if the student is not learning (Smith & Ragan, 1993). Provision of instruction with explicit practice items is very important to the outcome of learning. Smith and Ragan (1993) suggested that learners should have several opportunities to practice the performance related to a specific objective to promote over-learning and automaticity of skilled performance. Student practice of instructional objectives is considered an essential element of well-designed instruction because appropriate practice during instruction gives students the opportunity to engage in activities similar to those in the objectives and assessed on an objectives-referenced test (Popham, 1969; Gagné, 1985).

Schnackenberg and colleagues (1998) found that the CBI that contained more practice resulted in learners scoring significantly higher on the posttest than CBI with less

practice. The object of good practice should be to convert a learning task that does not have much inherent meaning into something more meaningful (Salisbury et al., 1985).

Learning Goal Level and Instructional Strategy Design

Learning goal level is expected to influence the unit of instructional strategy design. The learning goal level influences how the instruction is organized and presented. CBI is judged to be successful when the essential content supports the learner's attainment of instructional goals (Hannum, 1988). Different instructional strategies are implemented based on the learning goal level to be achieved (Salisbury et al., 1985). Because different conditions are required for different learning outcomes, the nature of the events of instruction also differs for each type of learning outcome. CBI that incorporates events that are appropriate for the desired type of learning outcomes will be more likely to attain the desired learning goals (Wager & Gagné, 1988).

The learning goal level determines the type of learning for which the instructional strategy design must be developed. In the first two levels of Bloom's Taxonomy of the Cognitive Domain (1956), knowledge and comprehension, learners would be required to recall in verbatim, paraphrased, or summarized form facts, lists, names or organized information. The instructional strategy design would be developed for that learning outcome. In the application, analysis, synthesis, and evaluation levels of Bloom's Taxonomy of Cognitive Domain, students learn how to recall and apply other instances not encountered during instruction. Therefore, the instructional strategy design would be developed so that the learner can discriminate, acquire concrete and defined concepts, and learn rules or principles.

Tennyson and Foshay (2000) suggested that cognitive psychology offers two basic types of goals: the acquisition of knowledge and the employment and improvement of knowledge. Identifying which forms of knowledge acquisition and employment are feasible will help the instructional designer select appropriate instructional strategies in the design domain. An important design activity is defining the learning outcomes that relate to the goals of the learning environment.

Learning Goal Level and CBI Design

Learning goal level is expected to influence the components of instructional control and instructional support of the unit domain of CBI design. Learning goal levels based on Bloom's Taxonomy levels of knowledge and comprehension would be more likely to use program controlled CBI design, while learning goal levels of application, synthesis, and evaluation would use learner controlled or adaptive controlled. Romiszowski (1981) found that learner control was unsuccessful for some subjects because they did not have clearly formed objectives. These objectives are developed based on the learning goals that are to be achieved.

Hannafin (1984) suggested that instructional control is dependent upon the nature of the learning task. Procedural tasks, verbatim learning tasks, unfamiliar material, and tutorials are best taught by program control, while contextual and substantive information, higher order skills, familiar material, and drill and practice are better taught under learner control. Tennyson and Foshay (2000) reported that managing the learning environment should be consistent with the defined learning goals and objectives of the instruction. Trollip (1979) found that CBI used in teaching holding patterns and procedures resulted in significantly less critical errors, and the CBI group was better prepared mentally for the task.

Knowledge of the outcomes guides the designer in the amount of encouragement and/or amount of instruction needed in feedback to achieve the proper results without prolonging the learning process (Sales, 1988). Sales (1988) suggested that the most complex outcome for CBI is the development of cognitive strategies. Cognitive strategies are learned techniques for manipulating information. Knowledge of consequence feedback requires the learner to think through the instructional situation to determine which factors have combined to produce the results. CBI designed for higher level learning outcomes such as problem solving, rule learning, and defined concepts requires that the learners generate solutions to problems, demonstrate the use of rules they have learned, and classify objects based on the instruction they have received (Briggs & Wager, 1981; Gagne & Briggs, 1979; Smith & Boyce, 1984). Instruction at this level requires the learner to acquire new knowledge and to formulate, test, and refine hypotheses on the correct use of this knowledge. Elaborative feedback that provides explanation of errors as well as additional instruction may prove to be most effective.

CBI designed for lower level of learning outcomes, such as concrete concepts and discriminations, requires the learner to identify or to discriminate between specific members of the concept class presented in the instruction (Briggs & Wager, 1981; Gagne & Briggs, 1979; Smith & Boyce, 1984). Feedback that simply informs the learners of the correctness of their response will be sufficient in most cases. The learning outcome associated with verbal information helps learners memorize facts and labels. Feedback consisting of simple knowledge of incorrect response or knowledge of response should be adequate for this learning goal level. As the complexity of the information increases, the needs of the learners increases, and the level of feedback must be adjusted (Sales, 1988).

When verbal information of a verbatim or literal nature is the learning goal, program control provides for a greater degree of certainty of exactness. Contextual and substantive information are best taught using learner control. Learner control design permits the learner to form individually relevant associations among prior and current information, thereby deepening and enriching the level at which instruction is processed. Hannafin (1984) found that lower-order intellectual skills are best taught using program control, while higher order skills may be best taught using learner control. Program control is desirable for learning with established goals of mastery criteria. For CBI that does not have mastery criteria as a goal, program control is useful for tutorial and learner control useful for drill and practice. Program control is more effective for unfamiliar learning and learner control more effective for familiar learning (Ross & Rakow, 1981; Tobia, 1981).

CBI Design and Learning Outcome

The unit of CBI design precedes and influences the unit of learning outcome. Boettcher et al. (1981) suggested that learning outcomes are influenced not only by the mode of instruction, but by the level of the cognitive category. It is how CBI is used, rather than the fact that it is used, that determines learning effectiveness (Avner et al., 1980; Boettcher et al., 1981).

Instructional control, instructional support, screen design, and practice activities must be designed with the learning goal level and the appropriate instructional strategies for the learning outcome desired. CBI incorporating events that are appropriate for the type of learning outcome desired will be more likely to attain the desired learning goal (Wager & Gagné, 1988). Different types of CBI serve different roles in the instructional process. The various categories of learning outcomes differ notably in the expectations of learning results.

Each of the outcomes requires a different content organization for display and practice activities during the course of instruction. Formatting screen displays, placement of questions and response prompts on the screen, instructions to the learner about options under their control, and instructional support in the form of feedback, all impact the learning outcome.

Assessment is used to determine the learning outcome and the appropriate design of CBI. If the outcome is not met, a redesign of the CBI processes and instructional strategy may be required. CBI must be designed with the learning outcome firmly in mind.

Summary of the Laws of Interaction

A major conclusion to be drawn from the preceding discussion is that a change in one unit of the theory brings about subsequent changes in another unit of the theory. The following Laws of Interaction are derived from the dynamic relationships among the units:

Law 1. The units of self-directedness, external support, computer self-efficacy, instructional strategy design, learning goal level, and CBI design are required for the output of the desired learning outcome.

Law 2. The units of self-directedness and computer self-efficacy influence external support.

Law 3. The units of self-directedness, external support, computer self-efficacy, instructional strategy design, and learning goal level influence CBI design.

Law 4. Self-directedness, computer self-efficacy, and learning goal level are inputs into the process of CBI design.

Law 5. Learning goal level is input into the process of instructional strategy design.

Law 6. External support and CBI design-support have a 2-way relationship

- a. Strong external support will influence the amount of CBI design-support.
- b. Strong CBI design-support will influence the amount of external support.

Law 7. Instructional strategy design precedes CBI design as processes that are required for an output of the desired learning outcome.

Boundaries

A theoretical model is bounded when the limiting values on the units comprising the model are known (Dubin, 1978). Determining the boundaries of the theory enables the researcher to set and clarify the aspects of the real world that the theory is attempting to model. In setting the boundaries, the theoretical domain is distinguished from those aspects of the real world not addressed or explained by the theory (Lynham, 2002). Using Dubin's theory building method, the boundaries are determined not by empirical data, but through the use of logic to indicate the "domain over which the theory operates as a system" (Dubin, 1978, p. 141).

The boundaries of A Theory of Effective Computer-Based Instruction for Adults are first defined by the distinction between adult and non-adult. There appears to be no concrete age boundaries when referring to adults. For purposes of this theory, adults are defined as anyone 18 years of age or older. Adults approach learning on a need to know basis, using prior experience as a mental model for new knowledge. They are motivated by the impact of the new knowledge in contextual and life situations. For the purpose of establishing the boundaries of the theory, all humans are either adults or non-adults. Age will be used to determine whether or not humans are adults. If one concludes that the learner is either adult or non-adult, then the boundary becomes closed. Dubin (1978) advocated "a closed

boundary is used when exchange does not take place between the domains through which the boundary extends” (Torraco, 1994, p. 162).

The second boundary condition of “A Theory of Effective Computer-Based Instruction for Adults” exists within the domain of adult. The theory applies to computer-based instruction within the domain of adult. Computer-based instruction is defined as the delivery of instructional content by means of the computer to achieve learning goals through desired outcomes. The units of the theory fit within the domain of CBI. The goals or outcomes of computer-based instruction may be varied. Therefore, the boundary condition is an open boundary within the domain of adult as defined by Dubin (1978). “An open system is one in which some kind of exchange takes place between the system and its environment” (p. 126).

Two criteria for determining the boundaries of a theory are homogeneity and generalization. The criterion of homogeneity requires that the units employed in the theory and the laws of interaction satisfy the same boundary-determining criteria (Dubin, 1978). The units of the model must fit into the boundaries before the theory is complete. The units of self-directedness, computer self-efficacy, external support, instructional strategy design, learning goal level, CBI design, and learning outcome and the laws of interaction all fit within the open boundary of computer-based instruction and satisfy the criteria of the internal boundary.

The second criterion of generalization of a theory relates to domain size of the theory. The larger the domain, the more general the theory (Dubin, 1978). In this particular case, only two variables are held constant, adults and computer-based instruction. Employing two boundaries, one open and one closed, and applying two step-related criteria of homogeneity

and generalization enabled the researcher-theorist to determine that “A Theory of Effective Computer-Based Instruction for Adults” is not unlimited or unbounded.

The boundaries of the model are depicted in Figure 3 where the open boundary of the domain computer-based instruction is represented by the dotted oval line and the closed boundary of adult is represented by the solid oval line.

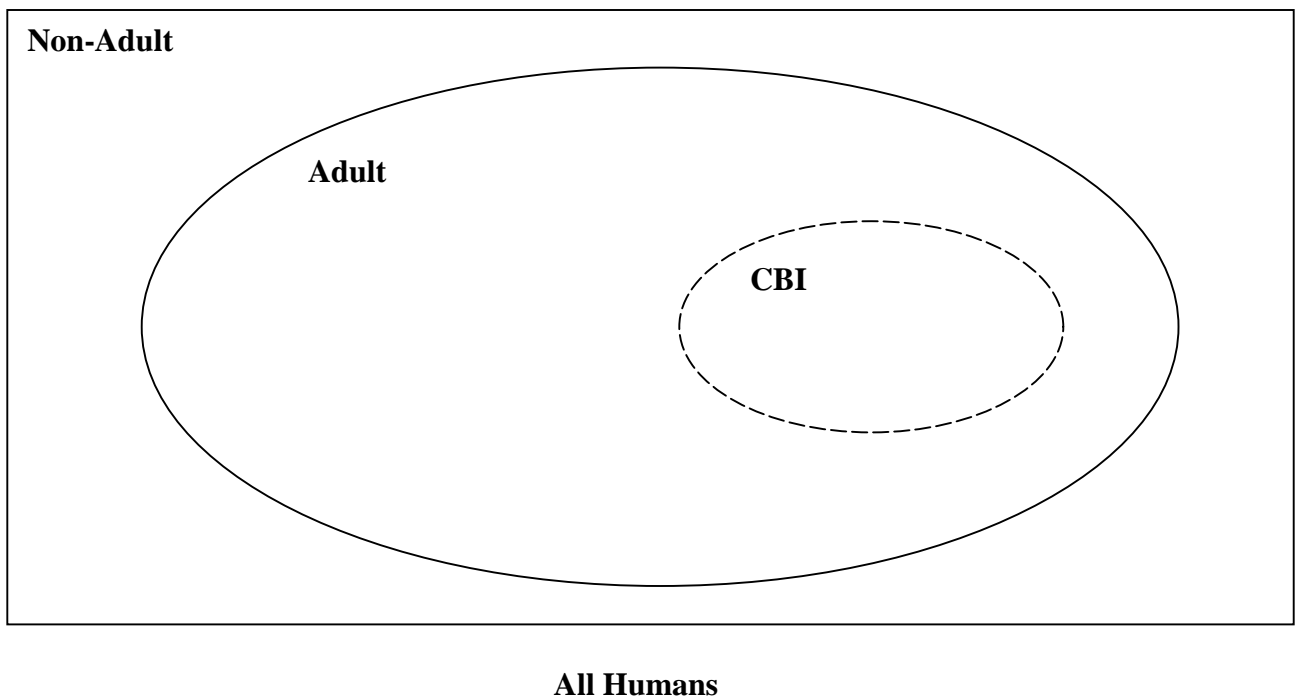


Figure 3: The Boundaries of a Theory of Effective Computer-Based Instruction for Adults

In summary, the domain within which “A Theory of Effective Computer-Based Instruction” is expected to hold is in the domain of adult. The distinction between adult and non-adult separates the domain of the theory from non-adult not addressed by the theory. Within the domain of adult, the theory applies to computer-based instruction. The boundary defining the application of the theory to computer-based instruction and adult is an open

boundary operating within the boundary defining the application of the theory to the domains of adult, a closed boundary.

System States

System states indicate the complexity of the real world that the theory is presumed to represent and the different conditions under which the theory operates. A system state is a condition of the system being modeled in which the units of the theory interact differently (Lynham, 2002). A system state is a state of the system as a whole and represents a condition under which the theory is operative (Dubin, 1978; Torraco, 1994, 1997, 2000). Dubin (1978) defined a system state as a condition of the system being modeled in which all the units of the system take on characteristic values and attributes that have persistence through time, regardless of the length of the time interval. All units of the system states are determinant and measurable and are distinctive for each state of the theoretical system (Dubin, 1978; Torraco, 1994; Lynham, 2002). A system state that accurately represents a condition of the system being modeled has three characteristics: (1) inclusiveness, in that all units of the system are included in the system state, (2) persistence, where the system state persists through some meaningful period of time, and (3) distinctiveness, where all the units take on unique values for that system state.

There are three system states that reflect different values and alignments that impact the output of effective CBI. The three system states are effective system state, ineffective system state, and moderately effective system state. In each of these three system states, the units of the system take on characteristic values for the single event of CBI.

Effective System State

In the effective system state, an alignment of both the upper support half and the lower design half of the model results in effective CBI. Different levels of support and design are required to meet learners' needs. In the support half of the model, two weak units must be balanced by two strong units for alignment in the support area. Four possible combinations of values of the units exist where support would be effective.

One possible arrangement of the support units would be strong self-directedness, strong computer self-efficacy, weak external support, and weak CBI design of instructional control and instructional support. A second possible arrangement where support would be effective would be strong CBI design of instructional control and instructional support, strong external support, weak self-directedness, and weak computer self-efficacy. A third possible arrangement of effective support would be weak computer self-efficacy, strong external support, strong self-directedness, and weak CBI design of instructional control and instructional support. A fourth possible arrangement of effective support would be strong computer self-efficacy, weak external support, weak self-directedness, and strong CBI design of instructional control and instructional support.

In the design half of the model, the units of design must be aligned with the units of support to provide for an effective model. The three units of learning goal level, instructional strategy design, and CBI design components of practice activities and screen design must be aligned to have appropriate design. The instructional strategy design should be matched with the learning goal level to be effective in the area of design. The CBI design components of screen design and practice strategy are developed from the instructional strategy design unit.

Therefore, if the instructional strategy is matched with the learning goal level, the design components of CBI design are more likely to be strong.

One possible arrangement of support and design would be a low learning goal level matched with the instructional strategy design and strong CBI design composed of the four components of instructional control, instructional support, screen design, and practice activities where support consist of weak computer self-efficacy, weak self-directedness and strong external support. Another possible alignment with the strong CBI design of the four components would be strong computer self-efficacy, weak self-directedness, and weak external support. To have an effective model for CBI, the four units of support must be aligned with the three units of design.

Ineffective System State

In an ineffective system state, the upper support half and the lower design half of the model are not aligned. The values of the units of support do not provide for effective support. A possible alignment would be that weak self-directedness, self-efficacy, external support, and CBI design would result in weak support. If computer self-efficacy is low, CBI design would not provide the instructional support needed, and external support would not be available to provide the support needed for low computer self-efficacy. If self-directedness is the weak unit, computer self-efficacy is likely to be weak as well, and poor external support and CBI design would make for an ineffective system state. Even if one unit of the support area is strong and the other three units are weak, the support area will be weak.

In the design half of the model for ineffective system state, the instructional strategy design is not appropriate for the learning goal level. Therefore, the CBI design would be weak since the instructional strategy design is an important input into the CBI design

process. A weak support area consisting of the units of low self-directedness, low computer-self-efficacy, weak or no external support, and weak CBI design resulting from instructional strategy design not being appropriate for the learning goal level, will result in ineffective CBI.

Moderately Effective System State

In the moderately effective system state, there exist two possible alignments. The first alignment consists of a strong support half with a weak design half and the second alignment consists of a weak support half with a strong design half. In most cases, the second alignment, one of weak support and strong design, exists in most CBI learning experiences.

In the possible alignment of a moderately effective system state, the units of self-directedness, computer self-efficacy, and external support are strong, with a weak CBI design resulting in a strong support configuration. However, a weak CBI design results when the instructional strategy design is not matched by learning goal level. Because of the strong support from three of the four units in the support area, the learning goal may be achieved despite the weak design.

If the instructional strategy design is not matched with the learning goal level, the CBI design is weak. This CBI design would need to be aligned with strong computer self-efficacy, strong self-directedness, weak external support, and weak CBI design components of instructional control, instructional support, screen design, and practice activities. Another possible alignment of weak CBI design is weak computer self-efficacy, strong self-directedness, and strong external support that would provide for moderately effective CBI.

In most organizations, the second alignment of weak support and strong design is typical. The instructional strategy design is based on the learning goal level and the CBI design uses both of these units in the design process. However, with three of the four units of support being low, computer self-efficacy, self-directedness and external support, the support configuration does not ensure that the program will be effective. The external support would need to be strong and the learning goal level would align with the instructional control and instructional support of the CBI design. Because most CBI is purchased off the shelf and is developed by instructional designers and programmers, it will have strong design. However, if the other components of support are not in place, no matter how good the design, the CBI will be moderately effective. The three system states of effective, ineffective, and moderately effective represent the conditions under which the theory of effective CBI for adults operate.

Evaluating Theory

Without the empirical testing of a theory, theories cannot be evaluated on their correctness or validity. However, a theory may be good without being totally correct. Patterson (1986, p. xx) provides eight criteria for evaluating theory with the following definitions:

1. importance – a quality or aspect of having great worth or significance; acceptance by competent professional may be indicative of importance
2. preciseness and clarity – a state of being clear; hypotheses or predictions can easily be developed from the theory
3. parsimony and simplicity – uncomplicated; minimal complexity and few assumptions

4. comprehensiveness – covering completely or broadly; covering the areas of interest related to computer-based instruction and adults
5. operationality – precise enough to be testable and measurable
6. empirical validity or verifiability – able to be confirmed or substantiated; experiments and experience that confirm or disconfirm the theory generate new knowledge
7. fruitfulness – predictions are made that can be tested and lead to the development of new knowledge; development of new knowledge is considered fruitful
8. practicality – provides a conceptual framework for practice

Using the construct analysis table list of authors, the authors were sorted in alphabetical order for first author, second author, third author and fourth author. From the sorting, the researcher-theorist was able to determine the number of articles that each of the authors had written. Researchers must have authored at least two articles to be included in the list of potential scholarly evaluators. This information can be found in Table 2, Authors Based on Number of Articles in Construct Analysis in Chapter 3. Thirty-four authors were identified as having written at least two articles for this study. Twenty-six were contacted and ask to evaluate “A Theory of Effective Computer-Based Instruction for Adults.” The rest of the scholars could not be located.

Since scholars of CBI are not expected to be experts in the theory building process, a scholar with knowledge of Dubin’s Theory Building Research Method was needed to evaluate the theory from the theory building method perspective. Also, CBI is often promoted as self-directed learning and the knowledge of an expert in this area would provide the appropriate evaluation of the theory from this perspective. Therefore, two additional

scholars, one in the area of theory building and one in the area of self-directed learning, were asked to evaluate the theory based on their knowledge in their particular area of expertise. The number of scholars that agreed to participate in the evaluation of the theory is found in Table 3 in Chapter 3. The scholars that participated in the external theory evaluation process were Dr. David Ayersman, Dr. Sharon Confessore, Dr. Steven Crooks, Dr. Susan Gray, Dr. Greg Kearsley, and Dr. George Marcoulides.

The scholars were sent a letter asking them to participate in the evaluation process. In the initial contact, they were also sent a list of questions and advised of the telephone interview. Those that agreed to participate were sent an email providing the time and date of the telephone interview that was prearranged after their agreement to participate. Scholars were also sent an evaluation package (Appendix D) that contained instructions for the evaluation process, an explanation of the criteria for evaluating the theory, questions to guide the telephone interview with a rating table, and the initial theory (Chapter 4).

Analyze and Synthesize Feedback

Six scholars evaluated “A Theory of Effective Computer-Based Instruction for Adults.” Each scholar was asked to rate the eight criteria for evaluating theory developed by Patterson (1986) on a scale of one to five, with one being very low and five being very high, and provide comments about the theory pertaining to the criterion being rated. A ninth question provided the evaluators an opportunity to provide any additional comments related to the theory. Five of the scholars comments were tape recorded and transcribed onto the evaluation form found in Appendix B. One scholar submitted his rating and comments on the evaluation form found in Appendix B. A summary of the ratings are found in Table 5.

The first criterion rated by the scholars was on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance” (p. xx). One scholar rated the importance as low, four scholars rated the importance as high, and one rated the importance as very high. The scholar that rated this criterion low commented that while the theory summarized and synthesized old research, it did not provide new explanations or predictions about computer- based learning. The researcher-theorist disagreed with the scholar’s

Table 5: Summary of Scholarly Rating of Criteria for Evaluating Theory

	Rating Criteria	1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance		1		4	1
2	Precision and Clarity			2	3	1
3	Parsimony or Simplicity			3	2	1
4	Comprehensiveness			2	2	2
5	Operationality		1	1	3	1
6	Empirical Validity		2		2	2
7	Fruitfulness		1		3	2
8	Practicality			3	2	1

comments based on the feedback from the other scholars which suggested that the summarized and synthesized research provided a comprehensive look at the many attributes that impact computer-based instruction for adults and provided a beginning framework for which research can be developed. The majority of the scholars found the theory important. To summarize their comments, the theory provides a framework for testing, and when proven the importance will become self-evident.

The second criterion rated by the scholars was the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to

do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). Two scholars rated precision and clarity as moderate, three rated precision and clarity as high, and one rated precision and clarity as very high. One of the scholars that rated this criterion as moderate suggested that a summary would make the theory more clear and precise. The other scholar that rated this criterion as moderate suggested that some of the concepts overlap but she was unable to provide specific examples. Upon review of the concepts, the researcher-theorist did not find overlapping constructs and, since the scholar was not able to provide specific information and none of the other scholars suggested such overlapping, the concepts were not changed. A synthesis of the scholar’s comments suggests that a summary of the theory would incorporate the conceptual model in narrative. This summary is found in Chapter 5. One scholar found that the theory contained both descriptive and prescriptive theories but was not sure of the purpose of the theory. When discussing instructional design theory, there are both prescriptive and descriptive theories that are included. The purpose of developing “A Theory of Effective Computer-Based Instruction for Adults” is to predict or explain why computer-based instruction for adults is effective and provide a framework for empirical research.

The third criterion rated by the scholars was the parsimony or simplicity of “A Theory of Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions. Three scholars rated parsimony or simplicity as moderate, two scholars rated parsimony or simplicity as high, and one scholar rate parsimony or simplicity as very high. The scholars recognized the challenge of the theory having

parsimony yet including all the units and relationships. One scholar that rated this criterion as moderate wondered if all the units made the theory stronger or more robust. The researcher-theorist reviewed the theory and was unable to remove any of the units from the theory. One scholar suggested that having a moderate rating in this criterion was not necessarily a bad thing. The more parsimonious the theory, the more of a risk you run in losing some explanatory value. Comments of the third scholar that rated this criterion as moderate were related to relationships of units in the model. The researcher-theorist disagreed with the scholar's comments for additional relationships between units based on the research reviewed.

The fourth criterion rated by the scholars was the comprehensiveness of "A Theory of Effective Computer-Based Instruction for Adults." A theory is comprehensive if it completely covers the area of interest and includes all known data in the field. Two scholars rated comprehensiveness moderate, two scholars rated comprehensiveness high, and two scholars rated comprehensiveness very high. The two scholars that rated comprehensiveness as moderate provided additional reference sources. Some of the information obtained from these additional references that add value to the theory was incorporated into the theory. The other scholars commented that it was quite comprehensive and focused on a particular aspect of reality. One scholar suggested that CBI be defined as a range. For purposes of this study, CBI is defined as the delivery of instructional content by means of the computer to achieve learning goals through desired learning outcomes. The computer may or may not require a computer connection to the network and does not typically provide links to learning resources.

The fifth criterion that was rated by the scholars was the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts. One scholar rated operationality low, one scholar rated operationality moderate, three scholars rated operationality high, and one scholar rated operationality very high. The scholar that rated this criterion as low found that the laws of interaction could be stated in a form that could be operationally tested or applied easily. However, the implications of the system states for the design and delivery of CBI needed to be elaborated. Because the theory has not been validated, this was not attempted by the researcher-theorist. Once validated, the system states of the theory would provide a helpful guide. The scholar that rated operationality moderate suggested more precision with definitions or more specificity of some of the aspects of the components of the theory related to self-directedness. In researching the definition of self-directedness the researcher-theorist found that there were a number of definitions to choose from. Straka (2000) reported that Carré had discovered well over 20 different terms for self-directed learning while Hiemstra had found over 200. To provide a definition that would please all scholars in this field would be somewhat unlikely. The definition for self-directedness was not changed.

The sixth criterion that was rated by the scholars was the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research. Two scholars rated empirical validity as low, two scholars rated empirical validity

as high, and two scholars rated empirical validity as very high. The two scholars that rated this criterion as low were concerned with measuring of the constructs. The likelihood of finding or conducting research that includes each of these constructs is doubtful in Ayersman's opinion. Conducting research that includes all the units of the theory would be a challenge and would require additional instruments being developed and validated to measure some of the constructs. The comments from the scholarly evaluators ran from "don't see it" to "there is a world of potential here." Since the propositions were not provided with the theory, some of the scholars were unable to see the potential. However, more of the scholars were able to see the potential than not. No changes were made to the theory because developing the empirical indicators were not part of this study.

The seventh criterion rated by the scholars was the fruitfulness of "A Theory of Effective Computer-Based Instruction for Adults." The capacity of a theory to lead to predictions that can be tested and lead to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory's propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research. One scholar rated fruitfulness as low, three scholars rated fruitfulness high, and two scholars rated fruitfulness very high. The scholar that rated this criterion as low suggested that the hypotheses be put in a more operational form. Since the propositions were not provided, this scholar referred to the laws of interaction as hypotheses. The laws of interaction only provide for relationships and not the development of hypotheses. The researcher-theorist agreed with the scholar that the laws of interaction that he referred to as hypotheses were not in the appropriate form for testing. The hypotheses for testing were not

part of this study. The scholars found that the theory focused research efforts and provided a systematic layout.

The eighth and final criterion that was rated by the scholars was the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles. Three of the scholars rated practicality as moderate, two scholars rated practicality as high, and one scholar rate practicality as very high. One of the scholars that rated this criterion moderate suggested the theory as a useful guide, but indicated that the rigor would be incredible and impractical because the thoroughness required would be quite time consuming. Another of the scholars that rated this criterion moderate expressed a need to see a recipe for practitioners developed from the theory included for practicality, while others could see it as a guide or framework for the practitioner. The third scholar that rated this criterion as moderate suggested that the system states could be useful for organizational planning if the implications of the different system states for making decisions about design and delivery were explained. Because the theory has not been validated, this was not attempted by the researcher-theorist. Once validated, this would provide a helpful guide. There is nothing as practical as good theory (Lewin, 1951). After validation of the theory, the prescription for practitioners should be derived.

Theory Modification

Based on the evaluations by the scholars, no changes were made to the theory. However, additional research literature was reviewed that would add to the support and research foundation of the theory.

Self-Directedness

Carré (2000) suggested that every professional trainer knows that the typical adult learner comes to the learning/training scene with a combination of motivation, educational habit, and self-image that predisposes them whether or not to learn. The concept of intention is at the core of efficient adult learning. Intentional learning can be defined as the voluntary search for knowledge, skills or attitudes of lasting value. When learning is intentional, the dynamics of educational engagement are mediated by a favorable motivational set, as opposed to the case of unintentional or compulsory learning situations, when the voluntary learning processes (attention, cognitive organization, metacognition) may or may not be involved, depending on the individual relationship to the context, thus resulting in hazardous learning outcomes (Carré, 2000).

The notions of will or intention to learn belong to the conceptual realm of motivation. A review of motivation in adult training established the importance of motivation in the learning process (Carré, 1998 cited in Carré, 2000). Specifically, motivation plays a central, although indirect, part in the learning process by: fostering motives which provide goals to the learning endeavor; focusing attention to processes, which favor short-term memorizing; allowing long-term memory work by facilitating cognitive organization; favoring deep-level/conceptual treatment of information; and promoting metacognitive learning strategies. Motivation plays a major role in the efficiency of adult learning efforts.

If the dominant characteristic of self-direction in learning is affiliated with the realm of psychological control (Long, 1989), a distinction can be made between intentional and self-directed learning. Self-direction demands two specific characteristics (Carré, Moisan, & Poisson, 1997 cited in Carré, 2000): proactivity and metacognitive competence. Proactivity is defined as the ability to initiate action and maintain active control. Metacognitive competence is the ability to reflect on the learning experience and improve the processes of learning. Carré (2000) suggested that intentional and self-directed learning appear closely related. Self-directed learning is necessarily intentional. Beyond intention, self-direction in learning requires proactivity and metacognitive competence. Beyond psychological control, self-directed learning benefits from pedagogical and organizational control.

Attention is drawn to the difference made between self and other-directed learning (Candy, 1991). Learning is other directed when what is learned and how it is to be learned is given from outside. Whether a learner keeps to this is another matter. Only the person doing the learning can determine whether or to what extent their experiences are internalized and realize the learning activities as self-directed (Straka, 2000). However, with reference to empirical research results, conditions may be provided to make self-directed learning more probable. On one hand this depends upon a person's internal conditions, especially his concept of himself, his knowledge, abilities, motives, interests, emotional dispositions, etc. Otherwise, the environmental conditions may be arranged to trigger the experience of competence, autonomy, and social relatedness (Deci & Ryan, 1985; Straka, 1997 cited in Straka, 2000).

Self-Directedness and CBI Design

Long (1988) suggested that self-direction in learning might be a better term than self-directed learning as the former is more amenable to the concept of degrees. It is easier to think of self-directed learning as being present or absent, while self-direction may be easier thought of as existing in varying degrees or levels.

Long (1989) suggested that adult self-directed learning has three conceptual dimensions: sociological, pedagogical, and psychological. The most popular usage of the term self-directed learning applies to the sociological dimension. As a consequence self-directed learning is equated with independent learning. Independent learning has two dimensions: (1) physical separation or isolation of the learner and (2) interpersonal power. The primary use of the sociological dimension is defined as learning that occurs in isolation, such as correspondence study and computer-based instruction. The second dimension, interpersonal power of the independent learner, is an autonomous learner for whom the parameters and learning activities are personally established. Both of these ideas tend to stress possible solitary behavior (Long, 1989) and ignore pedagogical distinctiveness and psychological implications.

The second concept of self-directed learning is focused on the pedagogical model. The degree to which learning is self-directed is determined by the freedom given the learner to set learning goals, identify and use resources, determine the effort and time allocated to learning, and decide how and what kind of evaluation of learning will take place. This concept does not require sociological isolation or autonomy of the learner.

The third concept is the psychological dimension. Long (1989) suggests that the critical dimension in self-directed learning is the psychological variable, “the degree to which

the learner, or the self, maintains active control of the learning process” (p. 3). Psychological control is the cause for self-directed learning. Autonomous learning as studied by Tough (1967) contained the greatest likelihood for psychological self-direction, in contrast with pedagogical direction. Pedagogical self-directed learning emerges from the interaction of psychological control and pedagogical control. When each of the forms of control is equal or when psychological control exceeds pedagogical control the situation can be described as a self-directed learning condition. When pedagogical control is excessive, the learner’s psychological control is limited, and learning becomes other-directed (Long, 1989). Emphasis on pedagogical procedures to the neglect of psychological process is a dead-end approach to studying self-direction in learning. Self-directed learning occurs only when the learner primarily controls the learning or cognitive processes.

Long (1989) pointed out that “the critical dimension in self-directed learning is not the sociological variable, nor is it the pedagogical factor. The main distinction is the psychological variable, which is the degree to which the learner or the self maintains active control of the learning process” (p. 3).

Long (1989) developed a theoretical framework that demonstrates the differing degrees of pedagogical and psychological influence in self-directed learning of adults involved in group activities. In Long’s model, he placed psychological control on the vertical axis and pedagogical control on the horizontal axis. The model consisted of four quadrates. In Quadrate I, the learner has high psychological control and the teacher uses low pedagogical control techniques. In Quadrate II, a condition of high psychological control and high pedagogical control exists. Quadrate III represents a condition of high pedagogical control and low psychological control. A situation distinguished by low pedagogical and low

psychological control is found in Quadrate IV. Long suggested that self-direction in learning is highest in Quadrate I and lowest in Quadrate III. In Quadrates I and III the psychological preference of the learner is matched with a non-threatening pedagogical structure. In Quadrates II and IV a mismatch exists and the learner is subject to threat and anxiety. In the situation represented by Quadrate II, the learner's psychological strength will be an asset, while in Quadrate IV the learner's relatively weak psychological strength will interact negatively with the relative absence of pedagogical structure.

Self-Directedness and External Support

Spear and Mocker (1984) derived the concept of the "Organizing Circumstance" which postulates that self-directed learners, rather than preplanning their learning projects, tend to select a course from limited alternatives within their environment that structures their learning project. They defined circumstance as a subjective concept, which gives meaning to the individual's environment, the reality that exists apart from or depends on concept or perception.

Spear and Mocker (1984) found in their study that the expectation of the learner, the individual's inventory of skills and knowledge, and the resources present within the environment were essential elements for understanding the self-directed learning process. The specific circumstances that provide the organization for self-directed learning were as varied as the learners and their respective settings. Each learner's circumstances were unique and the demographic characteristics appeared less important than the uniqueness of the individual circumstances (Spear & Mocker, 1984). Four inferences were drawn from their analysis:

1. The impetus or triggering event for a learning project or episode is a result of a change in life circumstances or is observed within the life space of the individual. Life space is defined as the physical, social, and psychological environment in which the individual lives and functions.
2. The changed circumstance tends to provide few resources or opportunities for learning that are reasonable or attractive for the learner.
3. The structure, methods, resources and conditions for learning are provided or dictated most frequently by the circumstances.
4. Learning sequences progress, not necessarily in linear fashion, but as the circumstances created during one episode become the circumstances for the next necessary and logical step.

Individuals bring to each episode or project their own motivation, aptitude, creativity, energy, and tenacity. They may differ in their ability to identify alternative means for learning present within the circumstance. However, this analysis suggested that the most powerful determinants lie within the circumstance, which tends to structure or organize the learning process.

The “Organizing Circumstance” focuses upon the structure and limits imposed upon an activity by environment factors in the individual’s life space. The environment has significant impact on human behavior, and to understand self-directed learning without reference to environment ignores both important research and common sense (Spear, 1988).

Propositions

A proposition of a theoretical model is a truth statement about the model in operation (Dubin, 1978). The propositions are grounded in the explanatory and predictive power

embedded in the theoretical framework constructed during the theory development process (Lynham, 2002). The only criterion of consistency is that truth be established by reference to only one system of logic for all the propositions set forth about the model (Dubin, 1978). It is important to note that the propositions are not truth statements about aspects of the real world that the theory represents (Torraco, 1994). One must convert the proposition statements first into empirical indicators, and second then into hypotheses, and third test the hypotheses through research to address the problem of matching the theory with the real world (Torraco, 1994).

The proposition statements are predictions about the model in operation if the units, laws of interaction, boundaries, and system states that characterize the model are known. The propositions of a model are all the truth statements about the conjoined values of two or more units whose relationship is expressed in the laws of interaction of the model. Dubin (1978) noted that the model or theory is a synthetic product, being constructed logically and intellectually by the theorist; therefore, the truth statements about the model are also synthetic. This synthetic quality of the propositions does not imply empirical accuracy of the propositions. Rather, the accuracy of a proposition is whether or not it follows logically from the model.

Dubin (1978) highlighted three types of proposition statements. The first type of proposition is about the values of a single unit being revealed in relation to the value of the other units connected to the unit in question by a law of interaction (Lynham, 2002). The second type of proposition “may be predictions about the continuity of a system state that in turn involves a prediction about the conjoined values of all units in the system” (Dubin, 1978, p. 166). The third type of proposition is a “prediction about the oscillation of the

system from one state to another that again involves predictions about the values of all units of the system as they pass over the boundary of one system state to another” (p. 166).

In specifying the propositions for a theory, there are three criteria for consideration by the researcher-theorist, consistency, accuracy, and parsimony (Dubin, 1978; Lynham, 2002). “The only criterion of consistency that propositions of a model need to meet is the criterion that their truth be established by reference to only one system of logic for all the propositions set forth about the model” (Dubin, 1978, p. 160). “The criterion of accuracy refers to whether the propositions follow logically from the theoretical framework to which they apply” (Lynham, 2002, p. 263). The criterion of parsimony refers to the selection of strategic propositions (Dubin, 1978). “The strategic propositions point out where something notable is happening to the values of one or more units” (p. 169). Therefore, it is not the job of the researcher-theorist to identify all possible propositions of the theory, but to seek some parsimony in the specification of propositions.

Nine propositions were specified for “A Theory of Effective Computer-Based Instruction for Adults.” The nine proposition statements logically derived from the theoretical framework are as follows:

Proposition 1: The level of learner self-directedness will be inversely related to the external support desired.

Proposition 2: The level of learner computer self-efficacy will be inversely related to the external support desired.

Proposition 3: The level of learner self-directedness will be inversely related to the CBI design components of instructional control and instructional support.

Proposition 4: The level of learner computer self-efficacy will be inversely related to the CBI design components of instructional control and instructional support.

Proposition 5: The learning goal level is inversely related to instructional control and instructional support in CBI design.

Proposition 6: The learning goal level directly influences the instructional strategy design.

Proposition 7: The instructional strategy design directly influences screen design and practice strategy in CBI design.

Proposition 8: The level of external support is inversely related to instructional support and instructional control in CBI design.

Proposition 9: The effectiveness of CBI will be maximized when the levels of self-directedness, computer self-efficacy, learning goal level, and external support are incorporated in the CBI design.

From these propositions, one would convert the proposition statements first to empirical indicators, and then into hypotheses, and then test the hypotheses through empirical research to address the problem of matching the theory with the real world for which the theory is intended to model.

CHAPTER 5

SUMMARY AND CONCLUSIONS

This study presents a theory of critical components that impact the effectiveness of computer-based instruction for adults. The theory was developed to provide a framework for research to explain or predict effective learning by adults using a desktop computer. This chapter summarizes the research questions findings, defines the limitations of the study, provides a conclusion for the study, and suggests implications for future research and practice.

Research Questions

In developing a theory of effective computer-based instruction for adults, five objectives or research questions were answered using Dubin's applied theory building method. The development of the empirical indicators, step six, and the hypotheses, step seven, of Dubin's applied theory building method are not a part of this study. The development of the empirical indicators and the hypotheses will be a part of the implications for future empirical research. The eighth and final step, also not a part of this study, is the empirical research which will be conducted to validate this theory.

Research Question 1: What are the Units or Variables of a Theory of Effective Computer-Based Instruction for Adults?

The units represent the properties of things whose interactions constitute the subject matter or the phenomenon that the theory is all about. The units represent the concepts about which the researcher is trying to make sense and are informed by literature and experience. By translating these concepts to units, the researcher was able to identify the variables whose interactions make up the subject matter of attention. The units enable the researcher-theorist

to answer the first objective of the study: What are the units of a theory of effective computer-based instruction for adults?

There are seven units identified as critical components in a theory of computer-based instruction for adults. The units are learning outcome, self-directedness, computer self-efficacy, learning goal level, instructional strategy design, CBI design, and external support. Learning outcome is defined as achieving learning goal level through appropriate instruction delivered by means of a computer. Self-directedness is defined as an approach where learners are motivated to assume personal responsibility and collaborative control of the cognitive and contextual processes in constructing and confirming meaningful and worthwhile learning outcomes (Garrison, 1997). Computer self-efficacy is defined as the belief that one has about their capabilities to successfully engage in CBI. Learning goal level is defined as the activities or performance required in the affective, cognitive, and/or psychomotor learning domains that result in the desired learning outcome (Gagné et al., 1992). Instructional strategy design is defined as elemental methods for determining and sequencing content, and presenting content and decision-making related to the content and its delivery. CBI design is defined as the programming of content and lesson design that incorporates the individual differences of the learner to achieve learning goal level delivered by means of the computer. External support is defined as providing for the needs of the learner that are external to the CBI program but are required to promote the learning outcome of CBI.

The conceptual model found in Figure 4 depicts the model as having input, process, and output units. There are three input units: self-directedness, computer self-efficacy, and learning goal level. The process units of the theory are instructional strategy

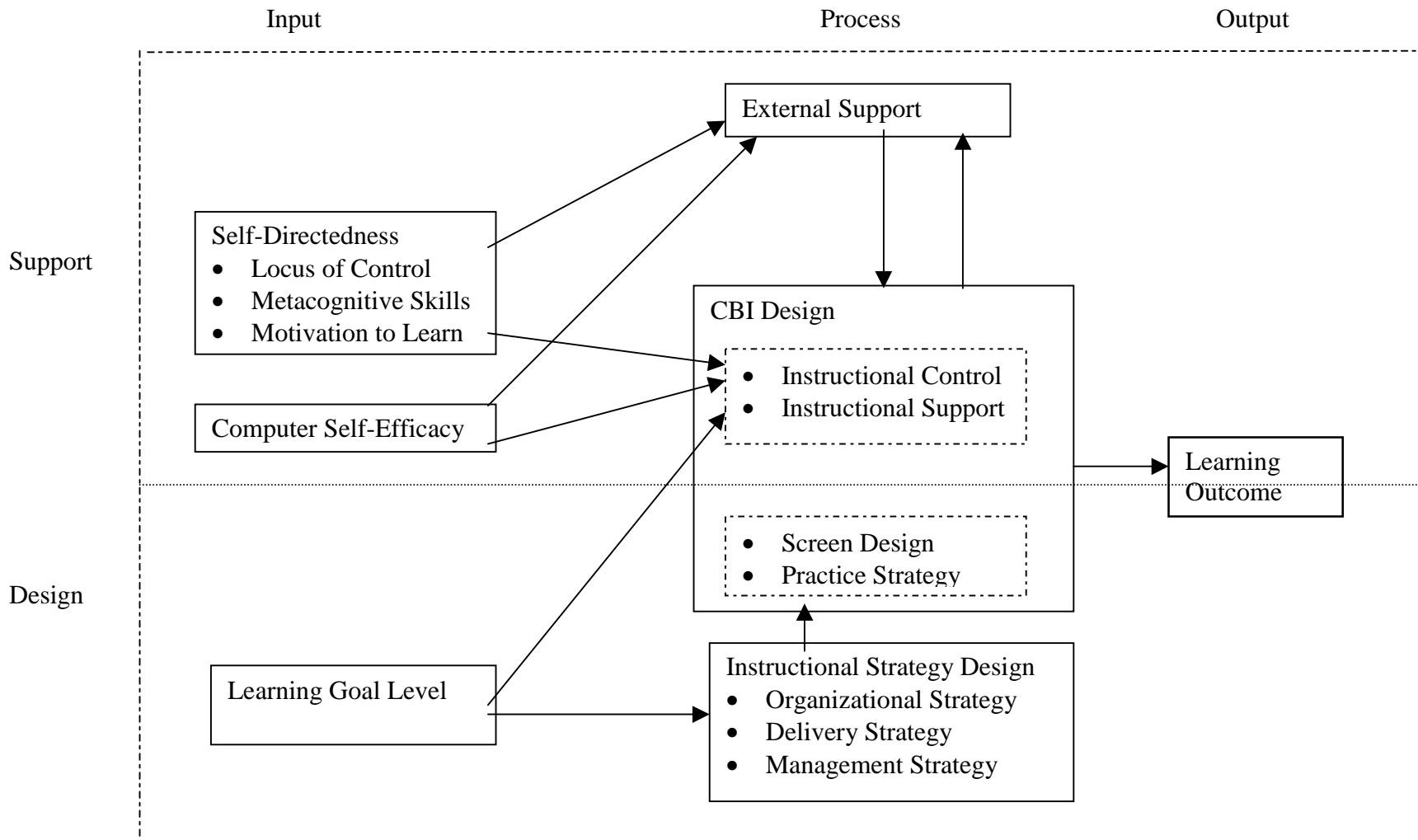


Figure 4: A Conceptual Model of Effective Computer-Based Instruction for Adults

design, CBI design, and external support. External support is considered to be a process unit because it requires the instructional designer to go back and forth between external support and CBI design to make sure appropriate support is provided. Finally, the output unit of the theory is learning outcome. These seven units and their interaction are the phenomenon that the theory is all about.

Research Question 2: What are the Laws of Interaction of a Theory of Effective Computer-Based Instruction for Adults?

The second step in the theory building method was to clarify which the units of the theory interact and relate to one another. The laws of interaction are statements by the researcher-theorist of relationships between the units and how they are linked. The laws of interaction do not necessarily indicate causality nor are they measured. The laws of interaction show how changes in one or more of the units of the theory influence the remaining units and enable the research-theorist to answer the second objective of the study: What are the laws of interaction of a theory of effective computer-based instruction for adults?

The input units of self-directedness, computer self-efficacy, and learning goal level have an effect on the condition or development of the process units. The two process units, external support and instructional strategy design, influence CBI design. The process unit of CBI design influences the output unit of learning outcome. A major conclusion drawn from this research is that change in one unit of the theory brings about subsequent changes in another unit of the theory. The following laws of interaction are derived from the dynamic relationships among the units:

Law 1. The units of self-directedness, computer self-efficacy, learning goal level, external support, instructional strategy design, and CBI design are required for the output of the desired learning outcome.

Law 2. The units of self-directedness and computer self-efficacy influence external support.

Law 3. The units of self-directedness, external support, computer self-efficacy, instructional strategy design, and learning goal level influence CBI design.

Law 4. Self-directedness, computer self-efficacy, and learning goal level are inputs into the process of CBI design.

Law 5. Learning goal level is input into the process of instructional strategy design.

Law 6. External support and CBI design-support have a 2-way relationship.

a. Strong external support will influence the amount of CBI design-support.

b. Strong CBI design-support will influence the amount of external support.

Law 7. Instructional strategy design precedes CBI design as processes that are required for an output of the desired learning outcome.

Research Question 3: What are the Boundaries of a Theory of Effective Computer-Based Instruction for Adults?

Determining the boundaries of the theory enables the researcher to set and clarify the aspects of the real world that the theory is attempting to model. The boundaries of a theory establish the real world limits of the theory and in so doing distinguish the theoretical domain of the theory from aspects of the real world not addressed or explained by the theory. The boundaries of a theory are important in that they enable the researcher-theorist to make clear and explicit the portions of the world within which the theory is expected to hold.

Dubin (1978) distinguished between a closed and open system. A closed system is usually defined as one in which there is no exchange between the system and its environment, while an open system is defined as a system where there is some kind of exchange over the boundary between the domains through which the boundary extends. The boundaries of a theory are determined not by empirical data but rather through the use of logic.

There are two boundary conditions of “A Theory of Effective Computer-Based Instruction for Adults.” The first boundary condition is a closed boundary and defined by the distinction between adult and non-adult, where adult is defined as anyone 18 years of age or older. The theory establishes the real world limits of the domain of adult. All humans are either adult or non-adult.

A second boundary condition exists within the domain of adult. The theory applies to CBI within the domain of adult. The units of the theory fit within the domain of CBI. There exists an exchange over the boundary between the domain of adults and the domain of CBI. The outcomes of CBI are varied depending on the adult. Therefore, the boundary condition is an open boundary within the domain of adult.

Research Question 4: What are the System States of a Theory of Effective Computer-Based Instruction for Adults?

A system state is a state of the system as a whole and represents a condition under which the theory is operative (Dubin, 1978; Torracco, 1994, 1997, 2000). All units of the system states are determinant and measurable and are distinctive for each state of the theoretical system. Dubin (1976, 1978) defined a system state as a condition of the system being modeled in which all the units of the system take on characteristic values that have persistence through time, regardless of the length of the time interval. All units of the system

have values that are determinant, meaning they are measurable and distinctive for that state of the system. In determining the system states of the theory, the researcher-theorist answers the fourth objective of the study: What are the system states of a theory of effective computer-based instruction for adults?

The conceptual model of the theory as seen in Figure 4 consists of two halves. The upper support half consists of self-directedness, computer self-efficacy, external support, and the components of instructional control and instruction support in the unit of CBI design. The lower design half consists of learning goal level, instructional strategy design, and the components of screen design and practice strategy in the unit of CBI design.

There are three system states that reflect different values and alignments that impact learning outcomes. They are an effective system state, an ineffective system state, and a moderately effective system state. Alignments of both the upper support half and the lower design half of the model results in effective CBI. In an ineffective system state, the upper support half and the lower design half of the model are not aligned. In the moderately effective system state, there exist two possible alignments. The first alignment consists of a strong support half with a weak design half of the model. The second alignment consists of a weak support half with a strong design half of the model. In most cases of computer-based instruction, the second alignment of weak support and strong design exists. For example, when CBI is bought off the shelf, it is designed with strong CBI design for the components of screen design and practice, good instructional strategy design, and the CBI design is appropriate for the learning goal level. However, the units of self-directedness, computer self-efficacy, and external support typically are not considered in the CBI design of instructional control and support. Therefore, the units that make up the support half of the

model are not aligned and CBI is moderately effective because of the exclusion of the alignment of critical components in the support half of the model.

Research Question 5: What are the Propositions of a Theory of Effective Computer-Based Instruction for Adults?

A proposition of a theoretical model is a truth statement about the model in operation (Dubin, 1978). The proposition statements are predictions about what is true in the operation of the units, laws of interaction, boundaries, and system states that characterize the model. The propositions are all the truth statements about the conjoined values of two or more units whose relationship is expressed in the laws of interaction of the model. The propositions are constructed logically and intellectually by the researcher-theorist. Because propositions can be subjected to empirical testing, the theory also may be subjected to empirical testing (Torraco, 2000). Propositions enable the researcher-theorist to make predictions about the values of the units of the theoretical framework in the real world (Lynham, 2002). The proposition statements were logically derived from the theoretical framework and enabled the researcher-theorist to answer the fourth objective of the study: What are the propositions of a theory of effective computer-based instruction for adults?

Proposition 1: The level of learner self-directedness will be inversely related to the external support desired.

Proposition 2: The level of learner computer self-efficacy will be inversely related to the external support desired.

Proposition 3: The level of learner self-directedness will be inversely related to the CBI design components of instructional control and instructional support.

Proposition 4: The level of learner computer self-efficacy will be inversely related to the CBI design components of instructional control and instructional support.

Proposition 5: The learning goal level is inversely related to instructional control and instructional support in CBI design.

Proposition 6: The learning goal level directly influences the instructional strategy design.

Proposition 7: The instructional strategy design directly influences screen design and practice strategy in CBI design.

Proposition 8: The level of external support is inversely related to instructional support and instructional control in CBI design.

Proposition 9: The effectiveness of CBI will be maximized when the levels of self-directedness, computer self-efficacy, learning goal level, and external support are incorporated in the CBI design.

Limitations of Study

Readers of this research should be aware of the two limitations of this study. First, as brought out in the evaluation of the theory by Dr. George Marcoulides, “there is no theory that one can put on paper that proposally models the richness of reality” (Appendix B, p. 262). Anytime that you try to model reality some aspects will be excluded. Being able to translate this theory into the real world in order to validate the theory is a limitation of this theory.

Second, the researcher-theorist’s own logic and objectivity influenced the outcome of this study. This theory was developed using Dubin’s theory building methodology. It is not a theory as defined by Gioia and Pitre (1990, p. 587) of “a coherent description, explanation, and representation of observed or experienced phenomena,” but it is a part of the theory

building research which “is the ongoing process of producing, confirming, applying, and adapting theory” (Lynham, 2002, p. 222).

Conclusions

Why do some adults start CBI but never finish? Why do some adults complete CBI without the desired learning outcome? Why hasn't CBI become the most used learning strategy for adults? This theory brings to the forefront some of the questions pondered by CBI researchers and practitioners. Five key conclusions can be drawn from this study that may help to answer these questions.

The first conclusion drawn is that characteristics of the adult learner play an important role in the designing of CBI for adults. Clearly, there are unique characteristics of adult learners that may significantly impact the design of CBI. The adult characteristics of self-directedness and computer self-efficacy were found to be important when using CBI. Adults possess different levels of self-directedness and computer self-efficacy and these differences should be taken into consideration. Adults with lower levels of self-directedness and computer self-efficacy would require more external support and program control of instruction. Those with higher levels of self-directedness and computer self-efficacy require less external support and more learner control of instruction. The component of instructional control of CBI design is important for those adults with a high level of self-directedness. When faced with program controlled CBI, they may become frustrated and not complete the instruction. Even with high levels of self-directedness, program control is required for new knowledge to ensure content is covered in a low learning goal level. If the level of self-directedness and computer self-efficacy are not aligned with the level of external support, the components of instructional control, and instructional support of CBI design, the adult

learner will not complete or obtain the desired learning outcome. CBI should be developed to respond to these individual adult differences.

The second conclusion drawn from this theory is that learning goal level impacts the instructional design strategy and the component of instructional control of CBI design. This requires both the instructional designer and the instructional technologist to work together to ensure an appropriate CBI design for the learning goal level. For lower learning goal levels, CBI should be designed with more program control. The lower learning goal level is usually new knowledge or a procedure that requires learning step by step. Adults tend to demonstrate more anxiety when new material is to be learned. Therefore, program control insures that the adult is exposed to all content in the proper order. On the other hand, higher learning goal levels should be designed with learner control of instruction. The higher learning goal levels foster the use of metacognitive skills possessed by the adult learner. Adult learners like to share their knowledge, and a cooperative learning experience would be beneficial at the higher learning goal level. The instructional designer should use instructional design principles in developing the instructional strategy design unit. The instructional design strategy should be developed to incorporate various activities that the adults may be involved in for active learning using CBI.

A third key conclusion of this study is that external and instructional support are extremely important. While the literature hints at the importance of external and instruction support, there is very little research in this area. Most research in instructional support is primarily in instructional feedback. External support and instructional support in CBI design helps to develop the attributes of self-directedness and computer self-efficacy in adults. One way to help adults improve their self-directedness or computer self-efficacy is to provide

positive experiences. By providing external support, adults receive encouragement and have opportunities for positive experiences. This may be in the form of allowing the adult learner to engage in CBI during working hours, providing a computer lab with the appropriate hardware and software for CBI, praise for the adult learner's participation in the CBI, or a peer providing positive feedback about the experience. If adults are frustrated because external support is not available to answer their questions or provide assistance, the experience becomes negative and they are not likely to engage in CBI again. The facilitator and the organization that is sponsoring the CBI should make available the external support that the adult learner needs.

Instructional support in CBI is a component of the CBI design unit in the support half of the model. Feedback is one way of providing instructional support. This support should be delivered in small doses with the opportunity to obtain more information if needed. This requires learner control for feedback to be a part of the CBI design. This is not to say that the adult learner would have complete learner control of the entire program. By giving the adult learner some control of their learning they will develop additional skills and have positive experiences that will improve their level of self-directedness and computer self-efficacy. When the adult learner can find the support they need, their computer self-efficacy level should improve.

A fourth conclusion drawn from this study is that CBI design is interwoven with the units of self-directedness, computer self-efficacy, learning goal level, instructional design strategy, and external support. This is not a simple relationship. Using software that converts face-to-face instruction to CBI is only part of the elements to be considered in developing effective CBI. It is important to note that successful CBI must consider the

alignment of each of the units of this theory to be effective. The support half of the model is equally as important as the design half of the model in designing effective CBI. Not only are all units required, but they must be matched to provide appropriate levels of each unit to achieve the desired learning outcomes. If both self-directedness and computer self-efficacy are at a low level, then both external support and the support part of CBI design must be at a high level for the support level to be aligned. Likewise, if the learning goal level is low and the instructional strategy design is appropriate for the learning outcome, CBI design must be aligned with the support half of the model to be effective. There are many combinations of aligning the support half with the design half, but no matter what the combination, there must be a match for effective CBI.

Finally, this theory draws together the isolated variables that researchers have considered important in the adult learning process and aligns them to provide for effective CBI. This study provides a theoretical relationship and interaction between the variables. Many of these variables have been suspected as being important to CBI but have not been presented in a comprehensive, systematic manner. Many researchers have looked at these variables individually and identified small sets of variables as necessary components in CBI. However, few have attempted to develop a theory that incorporates so many variables because of the complexity of adults and CBI. This theory provides a framework for research and, when validated, will provide a guide for the practitioner.

As technology continues to advance in this information age, the use of computers for individualized instruction becomes more affordable. Computers that can respond to the individual's response truly provide for individualized instruction. As additional knowledge and skills continue to be needed by the adult population to enhance their job situation or

provide for educational growth, the use of computers will continue to increase for training and education. The need for a framework upon which to develop effective computer-based instruction has become more evident. “A Theory of Effective Computer-Based Instruction for Adults” provides the framework to drive research and provide guidelines for practice.

Implications for Future Research

There are three major implications for future research provided by this study: developing and refining empirical indicators, developing and testing hypotheses, and designing empirical research.

Developing and refining empirical indicators is the first major implication for future research. Research, which follows Dubin’s (1978) methodology for theory building and is intended to match the theory with the real world, begins by converting the propositions of the theory into hypotheses that can be tested through empirical research. This is done by operationally defining key concepts of the theory with enough precision that each concept can be measured (Torraco, 1994). Dubin (1978) refers to the specification of procedures for measuring key concepts as producing the empirical indicators. An empirical indicator is an operation employed by a researcher to secure measurement of values of the unit. The empirical indicators are a translation of the theory’s propositions into measurable statements. The researcher-theorist would begin the empirical research by determining the empirical indicators.

There are several instruments that have already been developed that could be used to measure units of the theory. In measuring self-directedness, two different instruments were found: Guglielmino’s Self-Directed Learning Readiness Scale (SDLRS) (Guglielmino, 1977) and Oddi’s Continuing Learning Inventory (OCLI) (Oddi, 1986). Instruments for

providing a measurement for the component parts of self-directedness were also found. For the component of locus of control, there is Rotter's (1966) Internal-External LOC, which provides a locus of control continuum and the Nowicki-Strickland Adult Internal-External Survey (Nowicki & Strickland, 1973). Lawler's Motivation Potential Score (1981) provides a measurement for the motivation to learn. The metacognitive component could be measured by the adult's ability to solve problems. This measurement would be a continuum from low metacognitive abilities to high metacognitive abilities. A specific instrument for measuring metacognitive skill was not found by the researcher-theorist. Therefore, a Likert scale instrument could be development to measure the metacognitive abilities.

In measuring the computer self-efficacy unit, there are several instruments that the researcher may consider: Computer Attitude Scale (Loyd & Gressard, 1984), Computer Competence Instrument (Martinez, 1988), Computer Anxiety Scale (Marcoulides, Rosen, & Sears, 1985), and Computer Self-Efficacy Instrument (Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999). A Personal Computer Competency Instrument (PCCI) was developed by Bersch (1990) in her dissertation and used by Barrett (1991) in her dissertation. A factor analysis of these measurements may be required to determine the correlation between the variables and overlapping of instruments.

The unit of learning goal level can be measured using the taxonomy of the affective, cognitive, or psychomotor domains. This measurement could be assigned a number depending upon the learning goal level to be obtained. For instance, if CBI is used for a learning goal of application then a number of three could be assigned as a learning goal level.

No instrument was found that would measure the unit of external support. Therefore, the researcher would need to address the measurement of this variable. A survey of adults

could be conducted to determine what adults look for in the area of support from their family, peers, supervisor, technical support, organization, etc. Then a measurement instrument could be developed using a Likert scale to determine levels of support that could be used in empirical research.

The unit of CBI design is made up of screen design, practice, instructional control, and instructional support. The different levels of each component could provide a measurement of this unit. Some possible considerations for this unit would be learner controlled or program controlled practice and feedback. The screen design could provide for full or lean text with options for additional information. There are a number of possibilities that could be considered with this unit. Holding certain components of this unit constant may be a consideration for a quasi-experimental design.

An instrument was not found that would measure the instructional strategy design unit. To measure this unit may require that it either follows or does not follow appropriate instructional design principles. Holding this unit constant may be a consideration for a quasi-experimental design.

The learning outcome unit will be the dependent variable. One would need to know what is to be learned before an instrument could be developed to measure this unit. This instrument would be developed during the CBI instructional design process.

The second major implication for future research is the development and testing of the hypotheses. Once the empirical indicators are determined or developed, the next step would be to convert the propositions into hypotheses. The hypotheses convert the propositions into testable hypotheses using the empirical indicators as variables in the hypothesis statements. They predict what will be true in the real world if the phenomena of

interest behave according to the theory. Hypotheses derived from theory are known as deductive hypotheses. They drive the research process, which is ultimately intended to produce data to either support or disconfirm the theory.

Dubin (1978) used the concept of “perpetual theory building” (p. 220) to indicate that one is never done with theory building. The notion of ongoing theory building, of ongoing refinement of the theory is based on the results of research and testing and the use of those results to further inform and continually develop and improve the theory (Lynham, 2002). For example, beginning with proposition 1, the researcher would deduct the following research hypothesis: Hypothesis 1: The adult learner’s self-directedness as measured by the Self-Directed Learning Readiness Scale (SDLRS) is inversely related to the amount of external support as measured by the External Support Scale for effective CBI. This research hypothesis needs to be converted into a null hypothesis in order to be tested by statistical procedures. The null hypothesis would be: There is no relationship between self-directedness as measured by the SDLRS and external support as measured by the External Support Scale for effective CBI.

The third major implication for future research is the need for design of empirical research studies. In designing empirical research studies to validate this theory, there are a number of different research designs that could be employed. It will take a numerous studies to fully validate the theory. One approach is to design quasi-experimental studies focusing on subsets of the variables. For example, the researcher could focus on the relationship between certain support variables. The dependent variable would be the learning outcomes, which would be determined by a posttest. The researcher would need two groups of adults that had signed up for CBI. Both groups would be given an instrument that would measure

their self-directedness and computer self-efficacy. The treatment for group one would be to provide external support and group two would not receive any external support during CBI, including not being able to ask anyone else in the group for help. All other variables such as learning goal level, instructional strategy design, and CBI design would be held constant. If the theory is valid, differences in learning outcomes should be found.

Another approach for examining these seven variables would be to use structural equation modeling (SEM) in a non-experimental design. Structural equation modeling provides a straight forward method of dealing with multiple relationships simultaneously while providing statistical efficiency, assessing the relationships comprehensively, and providing a transition from exploratory to confirmatory analysis (Hair et al., 1998). For this theory, the confirmatory modeling strategy is the most direct application of SEM. The researcher would take the conceptual model in Figure 4 and use SEM to assess its statistical significance. Hair et al. (1998) identified seven stages in SEM: (1) develop a theoretically based model, (2) construct a path diagram of causal relationships, (3) convert the path diagram into a set of structural and measurement models, (4) choose the input matrix type and estimate the proposed model, (5) assess the identification of the structural model, (6) evaluate the goodness-of-fit criteria, and (7) interpret and modify the model, if theoretically justified. In this study the theoretical model has been developed. The other five steps would need to be followed. The researcher would begin by developing a precise path diagram, which would represent predictive and associative relationships or correlations among the constructs. The path diagrams are defined in terms of the construct and the researcher would use the empirical indicator variables to measure each construct. For instance, the constructs of self-directedness and external support may be shown with a curved arrow joining each to

represent a correlation between the two independent constructs, and a straight arrow from each of these constructs pointing to the construct of CBI design, the dependent variable. The path diagrams would be translated into structural equations and the remaining steps of the SEM would be followed. After completion of the sixth step, the goodness-of-fit criteria would be used to assess the validity of the path model and determine whether or not to modify the model.

Some of the implications for future research are found in the comments made by the scholarly evaluators. Dr. George Marcoulides had this to say about the theory: “The originality of the theory, I think clearly in the literature that I know of, no one has ever really brought to fruition all the various aspects of the design and the various processing steps that occurred. And so I see this as a very unique and comprehensive attempt to look at CBI not only for adults. I know you talked about adults but I think all CBI” (Appendix B, p. 264). Dr. Steven Crooks commented, “I was thinking as I was going through that my students probably ought to read this to generate ideas for research” (Appendix B, p. 247).

Implications for Practice

What does this theory provide for the practitioner? Without empirical validation, this theory must be used cautiously by the practitioner. However, the potential is great and there are limited uses that are appropriate even without validation. It gives the practitioner some variables to consider when using CBI as a means of instruction. As practitioners, even though they may not have had a theory to follow before, through their own experiences in working with CBI they have seen what seems to work best for the adult learner. They may have also wondered why the CBI had not worked on some occasions. This theory provides the practitioner with other variables to consider when providing CBI for adults. Two aspects

of the theory offer particularly important implications for practitioners: the importance of external support and the need for instructional control in CBI design to match the learning goal level.

The first implication for practice is the importance of external support to have a positive CBI experience. Most practitioners know that each adult learner has his or her own reason for learning and that each adult learner is different. The practitioner realizes that there are different levels of self-directedness and computer self-efficacy, they often overlook the importance of external support to CBI. External support can make the difference between a positive experience and negative experience for the learner. Practitioners know that negative experiences with CBI will keep the adult from returning to the next CBI experience. Therefore, creating a positive experience with CBI requires that external support be carefully considered as part of CBI.

The second immediate implication for practice is the importance of the learning goal level matching the level instructional control. The lower the learning goal level the more program control is required. Why is this? The lower learning goal level is usually new knowledge or a procedure that requires learning step by step. Adults tend to demonstrate more anxiety when something new is to be learned. Therefore, program control would insure that the adult is being exposed to all the content in the proper order. Many adults want to control their own learning, which is part of their self-directedness. However, because not all adults possess the level of metacognitive skills necessary to navigate through CBI, program control is usually needed at the lower learning goal levels.

In situations when the learning goal level is high, learner control should be more prevalent. If the adult learner is engaged in a higher level learning goal, they possess

metacognitive skills that allow them to navigate through CBI on their own. If not, then external support becomes even more important. Adults like to share their knowledge with peers, and in a high learning goal level, this provides a great opportunity for CBI cooperative learning. These realizations may be helpful to the practitioners before the theory is validated.

One of the scholarly evaluators, Dr. Sharon Confessore, made the following comments concerning the theory and its immediate implications for practice: “As I sat here looking at this, I thought that this is interesting because we are in the middle of a massive training program and we are going to include CBI. And I am looking at this thing and I am thinking that it is really interesting as I think about my positions and where they are placed on all of this. The factors that you have here are clearly the ones that we are asking about from a theoretical perspective. My overall sense of what you have done here is that you have done a very good piece of work and very interesting study“ (Appendix B, pp. 243-244).

The coming years will demand that learning occurs faster, in more diverse places, across more cultural and national boundaries, and with more efficiency (Flanagan, 1999). The real challenge is to find new ways to implement effective and efficient learning technologies that deliver immediate, strategic, and influential results (Ruona et al., 2003). This theory will provide a framework for more effective delivery of CBI for adults.

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APPENDIX

APPENDIX A
CONSTRUCT ANALYSIS TABLE

CONSTRUCT ANALYSIS TABLE

Article #	Construct Analysis Table																		
	Date	Authors	Students	Aptitude	Attitude Toward Computer	Computer Anxiety	Computer Efficacy	Learning Environment	Gender	Individual Differences	Learning Styles	Learner Motivation	Locus of Control	Outcomes	Feedback	Control	Group Learning	Practice	Others
1	1993	Premkumar, Ramamurthy, King	Graduates	1	1			1	1	1				1					support system
2	1993	Carlson & Wright	Undergraduates			1													speech anxiety
3	1989	Gray	Undergraduates		1					1			1	1					sequence control
4	1985	Cambre & Cook	Undergraduates			1													review of studies
5	1991	Massoud	Adults		1	1	1		1										age
6	1990	Marcoulides	Undergraduates					1						1					
7	1990	Harrington, Mc Elroy, & Morrow	Undergraduates			1					1								self-directed
8	1990	Shlechter	Adults	1													1	1	procedural learning task
9	1985	Allen & Merrill								1			1						learning strategies
10	1990	Kinzie										1	1			1			self-directed
11	1985	Hythecker, Rocklin, et al.	Undergraduates											1			1		
12	1985	Collet & Shiffler	Graduates		1									1				1	
13	1988	Schloss, Wisneiewski, & Cartwright	U & G		1								1	1	1	1			
14	1988	Marcoulides	Undergraduates	1		1													experience
15	1986	Steinberg, Baskin, & Hofer	Undergraduates										1		1				
16	1992	Leso & Peck	Undergraduates			1													
17	1991	Watson & Behnke	Undergraduates									1		1					
18	1999	Schulman & Sims	Undergraduates											1					
19	1977	Tsai & Pohl	Undergraduates											1					
20	1967	Schwartz & Long	Adults	1										1					time
21	1966	Schwartz & Haskell	Adults											1					time
22	1976	Swigger	Undergraduates											1					time
23	1976	Roe & Aiken	Undergraduates											1				1	
24	1974	Skavaril	U & G											1				1	time
25	1979	Trollip	Adults											1				1	
26	1978	Crawford & Crawford	Adults											1				1	
27	1992	Shaw	Adults	1								1	1	1		1		1	
28	1984	Davis & Mount	Adults											1					
29	1983	Dossett & Hulvershorn	Adults											1			1		time
30	1992	Stephenson		1					1					1			1		small groups
31	1992	Stephenson	Undergraduates				1							1	1		1		social aspects of team partner
32	1991	Stephenson	Undergraduates											1				1	instructor interaction
33	1985	Belland, Taylor, Canelos, & Dwyer	Undergraduates					1		1				1		1			pacing, graphics & text
34	1987	Koohang	Undergraduates	1	1				1										computer experience
35	1988	Ross, Morrison & O'Dell	Undergraduates		1								1	1					low-density & high-density text
36	1986	Wager	Adults		1									1					compared to television
37	2000	Schnackenberg & Sullivan	Undergraduates	1						1			1	1		1			text, time
38	1991	Pridemore & Klein	Undergraduates	1									1	1	1				
39	2000	Herrington & Oliver	Adults					1											situated learning environment
40	1982	Bonner																	
41	1984	Clark				1				1		1	1	1					transfer of learning
42	1984	Hannafin								1			1						learning task
43	1981	McCombs	Adults					1				1		1					
44	1997	Barab, Bowdish, & Lawless	Undergraduates				1												perceived utility & interest
45	1997	Hill & Hannafin	Adults				1												learner strategies
46	1998	Schnackenberg, Sullivan, Leader & Jones	Undergraduates		1					1			1	1		1		1	full and lean programs
47	1972	Van Dyke	Undergraduates		1				1						1	1			time
48	1982	Reiser & Gagné						1		1				1					media attributes

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CONSTRUCT ANALYSIS TABLE

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	Date	Authors																	
49	1998	Doillon & Gabbard						1		1	1		1	1		1			review of literature - hypermedia
50	1983	Steinberg	U&Adults					1						1					problem solving in unfamiliar context
51	1986	Batte, Fiske & Taylor	Undergraduates		1									1					evaluation of computer literacy course
52	1986	Marshall & Bannon	All		1				1										computer knowledge & age
53	1986	Loyd & Gressard	Adults		1	1			1										computer experience
54	1987	Honeyman & White	Adults		1	1												1	level of experience helps to reduce anxiety
55	1988	Schloss, Sindelar, Cartwright & Smith	Undergraduates										1	1	1				low & high achieving performance
56	1988	Yuen	Adults		1														experience, availability, community type, level
57	1988	Sales & Williams	Undergraduates								1		1	1	1			1	
58	1989	Kay	U & G		1				1				1						experience(computer literacy) & commitment
59	1989	Byrd & Koohang	Undergraduates		1														usefulness of computers
60	1989	Kay	U & G		1								1						computer literacy & experience
61	1989	Koohang	Undergraduates		1	1	1		1										experience & usefulness of computers
62	1989	Violato, Marini & Hunter	Undergraduates		1	1			1										usefulness of computers
63	1989	Wu & Morgan	Undergraduates		1				1										amount of use & perception of benefit
64	1990	Massoud	Adults		1	1	1		1										factor validity of computer attitude scale
65	1990	Arthur & Hart	Adults		1														cognitive ability & computer familiarity
66	1990	Kay	Adults										1						computer literacy
67	1992	Davidson, Savenye & Orr	Undergraduates								1			1		1			
68	1992	Hignite & Echternacht	Undergraduates		1	1													computers in education & as a tool for teachers
69	1992	Liu, Reed & Phillips	Undergraduates		1	1			1										experience
70	1992	McGrath	Undergraduates					1					1	1		1			time, hypertext
71	1991	Baack, Brown & Brown	U & Ret.		1														experience/use
72	1991	Turnipseed & Burns	B & Adults		1														future role in society
73	1995	Freitag & Sullivan	Adults								1		1	1		1			full and lean programs
74	1994	Ullmer																	
75	1994	Ertmer, Evenbeck, Cennano & Lehman	Undergraduates		1		1												experience & perception of increased competency, time
76	1994	Kumar, Helgeson & White																	hypermedia & cognitive psychology
77	1994	Klein & Pridemore	Graduate									1		1					behavior for TV

Students:

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CONSTRUCT ANALYSIS TABLE

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	Date	Authors																		
78	1993	Orey & Nelson																	1	
79	1996	Land & Hannafin																		open-ended learning, self-directed
80	1996	Crooks, Klein, Jones & Dwyer	Undergraduates		1								1	1			1	1		full & lean text
81	1996	Kellenberger	Undergraduates		1		1			1		1								motivation theory
82	1995-96	Perkins	U & G		1	1		1	1					1	1				1	computerized testing
83	1989	Newby & Alter	Undergraduates									1		1				1		intrinsic vs. extrinsic reward
84	1989	Ross, Morrison & O'Dell	Undergraduates		1					1			1	1		1			1	instructional support
85	1992	Hicken, Sullivan & Klein	Undergraduates		1			1					1	1			1			full & lean programs, time
86	1999	Jones & Paolucci																		evaluating effectiveness of technology on learning & achievement
87	2000	Mitra & Steffensmeier	Undergraduates		1			1												networked campus
88	1991	Barrett	Adults								1									self-directedness, graphic & text interface
89	1998	Karsten & Roth	Undergraduates				1							1						experience
90	1999	Takacs, Reed, Wells & Dombrowski	Adults								1									experience & stages of concern, hypermedia
91	1999	Ropp	Undergraduates		1	1	1			1										coping strategies & proficiency self-assessment
92	1997	Reed & Oughton	Graduate						1		1		1							experience & linear and non-linear navigation, hypermedia
93	1998	Zhang & Espenosa	Undergraduates		1		1													commitment of learning computer skills
94	1992	Baird & Silvern	Undergraduates											1	1					mode of testing - paper & pencil or computer
95	1992	Campbell	Undergraduates		1		1		1											experience, usefulness
96	1993	Hunt & Bohlin	Adults & U		1							1								experience
97	1993	Klein, Knupfer & Crooks	Adults & U		1									1						re-entry compared to traditional
98	1993	Delclos & Hartman	Undergraduates											1						
99	1993-94	Croy, Cook & Green	Undergraduates		1									1	1					participation, attitude toward instructor
100	1993-94	Maurer & Simonson	Undergraduates		1	1						1		1						experience & relaxation exercises
101	1993-94	Fogarty & Goldwater	Undergraduates										1	1		1				expert system
102	1994	Jones	U & G		1					1										computer use & cognitive style (MBTI)
103	1994	Ahern & Repman	Undergraduates															1		small group discussion
104	1980	Avner, Moore & Smith	Undergraduates													1				

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	Date	Authors																	
105	1994-95	Marcinkiewicz	Adults & U		1		1		1				1						age, preceived relevance, innovativeness, experience
106	1994-95	Overbaugh & Reed	Graduate		1	1													stages of concern; general vs course specific
107	1995	Astlertner & Keller										1						1	motivation theory model
108	1982	Federico	Adults	1						1				1					time, instructional modules
109	1988	Gray	Undergraduates		1								1	1					breadth/depth of menus, retention
110	1987	Gray	Undergraduates		1								1	1					linear vs branching (flip)
111	1974	White & Smith	Undergraduates		1					1			1	1		1			modules and audiovideo
112	1976	Jones & Sorlie	Undergraduates											1	1			1	
113	1977	Kearsley																	conceptual issues
114	1977	Dixon & Judd	Undergraduates		1									1				1	
115	1979	Forsythe & Freed	Undergraduates		1									1					programmed instruction & lecture
116	1979	Berkowitz & Szabo	Undergraduates							1				1			1		database & problems
117	1983	Conklin	Undergraduates		1									1					
118	1983	Federico	Adults	1						1	1			1					mastery learning
119	1983	Pohlman & Edwards	Adults & U											1					task number, graphics
120	1983	Morrison & Witmer	Adults		1							1		1					experience, task, branching
121	1983	McDonald & Crawford	Adults											1					long-term retention, video & graphics
122	1989	Reigeluth & Schwartz										1						1	
123	1989	Mahmood & Medewitz	Undergraduates		1	1	1			1		1							computer literacy, values, & phases of learning
124	1989	Whiteside, Lang & Whiteside	Undergraduates		1													1	value of CBI
125	1989	Hooper, Ward, Hannafin & Clark	Undergraduates	1						1				1			1	1	heterogeneous & homogeneous based on aptitude
126	1989	Grabe, Petros & Sawler	Undergraduates							1				1		1			reading ability & study skills
127	1990	Litchfield, Driscoll & Dempsey	Undergraduates											1					inclusive & adaptive sequencing, time
128	1990	Duin	Undergraduates				1					1					1		learner goals rather than system or concepts
129	1992	Kay		1	1				1										experience and use
130	1991	Hannafin & Carney	Undergraduates										1	1					cognitive and behavioral review strategies
131	1991	Milheim & Martin										1	1			1			attribution & information processing
132	1991	van den Berg & Watt	Undergraduates					1						1		1			hypertext system
133	1991	White, Troutman & Stone	Undergraduates											1	1				two levels of task performance

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	Date	Authors																	
134	1992	Carlson & Grabowski	Undergraduates				1		1	1				1					message design, time, embedded directions
135	1992	Billings & Cobb	Undergraduates		1						1			1			1		GPA
136	1992	Stephenson	Undergraduates														1	1	
137	1992	Santiago & Okey	Undergraduates										1	1					1 advisement
138	1993	Janniro	Adults											1					screen design strategies
139	1985	Wesley, Krockover & Hicks	Undergraduates										1	1					computer literacy
																			intrusive & less-intrusive feedback&
140	1985	Munro, Fehling & Towne	Undergraduates										1	1		1		1	dynamic skill, text
141	1981	Gaynor	Undergraduates											1	1				
142	1987	Sizemore & Pontious	Undergraduates		1									1					1
																			personality types, self-directed
143	1988	Kern & Matta	Undergraduates							1				1				1	
																			pedagogical design of presentational & interactive
144	2000	Cook																	outcome expectancy/organizational commitment
145	2003	Stone & Henry	Adults				1												goal setting & situational constraint variables
																			perceptions of interactive learning modules
146	2002	Jawahar	Undergraduates		1		1												perceived importance of CBI
																			minorities, access, & use of computers
147	2002	Kim, Williams & Dattilo	Undergraduates									1		1					experience, age, personality type
																			behavior of trainer that effects end user training
148	2002	Christensen	Adults		1	1													goal setting
149	2002	Chisholm, Carey & Hernandez	U & G				1												1 time, animation
150	2001	Orr, Allen & Poindexter	Undergraduates		1				1	1	1								framework
																			framework
151	2002	Compeau	Adults											1					framework
152	2001	Jawahar & Elango	Undergraduates		1		1					1		1					framework
153	1990	Rieber, Boyce & Assad	Undergraduates											1					screen design
154	1990	Tessmer																	framework
155	1990	Tessmer & Wedman																	framework
156	1985	Salisbury, Richards & Klein																	framework
157	1991	Aspillaga	Undergraduates											1					screen design
158	1982	Kearsley & Hillelsohn																	framework
																			meta-analysis/multiple-trial feedback
159	1993	Clariana													1				literature review/animation
																			framework
160	1990	Rieber																	overview
161	1993	Jonassen, Wilson, Wang & Grabinger																	response time to test questions
162	1985	Hofstetter																	
163	1988	Stokes, Halcomb & Slovacek	Undergraduates											1					meta-analysis/cooperative learning
																			framework
164	1991	Rysavy & Sales															1		
165	1979	Reigeluth																	
166	1992	Guthrie & McPherson	Undergraduates		1		1							1					

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	Date	Authors																	
167	1985	Burger	Undergraduates	1							1		1	1				1	
168	1986	Garhart & Hannafin	Undergraduates											1					inference understanding
169	1981	Rushinek, Rushinek & Stutz	Undergraduates		1													1	rating of instructor
170	1991	Carlson	Undergraduates							1				1			1		inductive & deductive instructional design
171	1988	Allred & Locatis																	
172	1993	Olivier & Shapiro																	
173	1979	Tennyson & Rothen														1			
174	1993	Reeves														1			
175	2000	Yildirim	U & Adults		1	1	1												
176	1993	Beard																	skill transfer
177	1979	Dennis	Undergraduates																mean latency, display rate & memory support
178	1981	Boettcher, Alderson & Saccucci	Undergraduates	1	1					1				1					
179	1990	Salisbury																1	literature review
180	1992	Shlechter & Bessemer	Adults											1				1	
181	1983	Montague, Wulfeck & Ellis																	literature review/instructional design
182	2001	Lou, Abrami & d'Apollonia															1		meta-analysis
183	1990	Kinzie & Berdel									1					1			
184	1996	Ayersman																	literature review of hypermedia-based instruction
185	1995-96	Ayersman & Reed	Undergraduates			1			1		1			1					
186	1995	Bowman, Grupe & Simkin	Undergraduates							1	1			1		1			self-directed, learner satisfaction
187	1997	Bratton-Jeffery	Adults										1	1					metacognitive strategies
188	1994	Brock & Sulsky	Undergraduates		1		1												
189	2001	Ratcliff	Undergraduates											1		1			time, self-directedness, ACT scores
190	1997	Seyler	Adults				1	1				1							organization commitment, supervisor support, peer support
191	1993	Grabinger	U & G						1				1						screen design strategies
192	1993	Park & Hannafin																	
193	1991	Cowen	Adults												1			1	
194	1994	Harris													1				meta-analysis
		Total		12	67	24	23	14	23	27	13	20	38	98	15	26	15	31	

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APPENDIX B
SCHOLARLY EVALUATION FORMS

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

Evaluator: Dr. David Ayersman

Title: Director, Instructional Technology Resource Center

Organization: West Virginia University

Field of Research: Individual differences, attitude toward computers, computer anxiety, performance

1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance				X	

Comments: I managed to read Chapters 3 and 4 you sent as well as the evaluation document. To be honest I don't actually see a theory yet. Do I? Is there something that I am missing? Maybe I am alone in my expectations but I read and read and I was building toward a momentum, here is my theory based on all the information. Maybe she is holding out waiting until she talks with everyone or something. Perhaps some kind of summary that would tie it all together. How would you convey this theory to someone? The document was 56 pages. And what would you say the purpose of the theory is?

It is obvious that you have put a lot of effort into this and I think you will end up doing pretty well with everything. I also think your choice of methodology has not allow you a simple solution to getting this completed but has presented you with quite a few challenges contacting people, collecting data and then sort of analyzing all of that will be quite a task for you to do.

To some extend the importance will be best commented after it has been derived. Testing it, proving it and then the importance will become self-evident.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity			X		

Comments: It is very thorough based on what I have seen. Turning that into something that is clear and precise as I said earlier it might be good to summarize much of the information. You might want to begin or end with a summary at some point in your document that brings it all together. That would make it much clearer for me and for others. I think that it would help clarify it for any reader. I would rate it a 3 without the summary.

3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity				X	

Comments: I think it is difficult to limit the number of concepts simply because there are so many variables involved. You are kind of at odds with yourself when you try to boil it all down to one thing and you just can't, that there are so many different parts to it. I would say you have done a very effective job of that and would rate it a 4. But certainly that is not unrelated to the previous comment that the summary would sort of help simplify that and make it more parsimonious.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness					x

Comments: The one question that I would have would be the definitions that your research articles had for CBI. To what extent did they agree or the way they defined it. As we know there are many different shapes and forms of CBI and sometimes-comparing apples to oranges, really. The way that we define that has a lot to do with how many assumptions we can make based on summarizing the research. The other end of that though would be the variables that you identified that were related to it. I think very comprehensive with that part of it.

I want you to be aware that this is all based on an assumption that the other part is in common and that might not be a good assumption. The CBI aspect of things is what I am talking about. If I am teaching my students to read with this program that I created and my manuscript is published and someone else is teaching geography with some completely different computer application, to what extent can we compare those two things? I mean all the other stuff is in common but it is the actual definition of CBI, which seems to be the place of uncertainty.

It is almost like you are hitting all around it but the actual thing itself. I mean one person could be exploring the effectiveness of online discussion with student for dialogue and the way that they do that could be very, very different from the way that someone else is looking at how well this tutorial works for learning math skills. Those two things are both CBI to some extent. And yet they are very, very different. And so lumping them all together is making a very big assumption and we all need to be aware of that. Define CBI as honestly as you can. All the studies that you have researched, you need to cover the gambit and say that the way that I have defined it ranges from this to that. In a way that you just did a few minutes ago verbally you could qualify that definition by saying that to some extent that it is not as important because of all these other variables that seem to be related no matter what kind of instruction it is. That all these things are related. Provide some explanation of scope of what was used for CBI in the research that you did. It is a little ambiguous without that.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality				X	

Comments: I think you did a very good job of identifying fundamental research on each of the key issues that you mention and you did show some of the relationships among them. And people that read your theory can go to those sources for additional information if they need it, for definitions and clarity and things like that.

6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity		X			

Comments: All this is really in the future. It will be difficult to predict but my guess is that because your definition of this theory includes so many different variables that you find very little research that encompasses all of them. Mentioned in your review of research, typically it is one or two factors that people look at. And if you come up with 6 or 7 it is unlikely that they are going to look at all of those when they do research. Even if they try to control for 4 or 5 of them, they still have to measure things. And so I doubt that you're going to really have a lot of research that is comprehensive enough to address each of those. Empirical validity is something that is difficult to prove. Ideally is one thing and practically is another in rating this category. At this point it is just a prediction of reality and I would rate it kind of low. But ideally, if you could write the recipe and then follow it and then you could come up with a high empirical validity. The question is whether or not they will follow the recipe.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

- 7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.**

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness				X	

Comments: One way that it could do that is by being so comprehensive that you have addressed multiply variables or include them in their research they will be able to see interaction, isolated and specific. To that extent, yes you can produce new knowledge. Certainly, over and over again you are going to hope to prove or disprove knowledge among the interactions of variables is an area that seems likely.

- 8. Please rate and comment on the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality			X		

Comments: I think it is going to be useful as a guide. That already makes it practical to people. Hey look, I’m interested in theory and I want to do some research, they would at least be aware of your theory that might provide the way for them to design their study. But whether or not they completely adhere, it might be a little impractical because it would be quite time consuming to be that thorough. The rigor would be incredible and so it is a very high standard. The ideal standard that I doubt many people would really reach. It serves to be a good guide.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

9. Please comment on any other aspect of “A Theory of Effective Computer-Based Instruction for Adults” that has not been previously addressed.

I would be interested in a final copy when you are done. Certainly very exciting and hope that you see it through. You have chosen a pretty difficult task here and hats off to you for that.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

Evaluator: Dr. Sharon Confessore

Title: Assistant Professor

Organization: The George Washington University

Field of Research: Self-Directed Learning

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance				X	

Comments: I think while we got lots of stuff around CBI for adults it is not collected in one place. And that what it does is it begins to get a framework around how we think about this topic.

- 2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity				X	

Comments: My only comment is that the diagram in the document, it is fine but it was a little bit difficult to follow in terms of your verbiage. I am not sure that it is a problem

A Theory of Effective Computer-Based Instruction For Adults Scholarly Evaluation Form

with the theory as much as how you have written your chapter. So for the standpoint of what you got here is precise and clear, the answer is yes. It was easy to follow and easy to understand, what it was you were telling me to do. It provides a clear set of objectives. It provides a beginning framework with places to start asking good questions for research purposes. For that stand point I think it is fine.

- 3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity				X	

Comments: It seems that what you have here is a good start, but the relationships sort of folds together where you may have a challenge with the parsimony is around the screen design and practice strategy stuff in the box. When you look at your chart you don't have any relationship built between any of your process stuff with regard to that box. What that did is that your connection between you self-directedness and your screen design that didn't get noticed. For instance, if I think about screen design and what it looks like in easy of operation and all that stuff. And I think about work on learner autonomy around what enhances or inhibits the likelihood of a person continuing to engage in a project. Part of that has to do with are they sorting getting value for their time invested? Screen design isn't a good design, then they won't persist with the CBI. They will go on to something else. So it is possible that there might be a connection between self-directedness and screen design and practice strategy. Now, that sort of bangs up against your parsimony issue. I don't know how you are going to resolve that. But my job is not to do that, my job is just to point it out.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness			X		

Comments: I would give this one a 3, possibly a 2. Particularly in with regard to the self-directed and there are two pieces to this. One was I was very surprised not to see in your work any work by Huey B. Long. Particularly around the piece that he did in the late 80s and early 90s where he looked at self-directedness and instruction across two pieces. One was degree or amount of structure in the instruction and the need of the learner to be --- What he did was using a horizontal and vertical axis he built a model and came up with four conditions. He talked about the fact that if you have a student with low self-directed in an environment with high learning structure then you have a learning match. If you have a student that has a low need for structure in a largely unstructured environment you have a match. But if you have a combination of a student that needs high structure in an environment that is not structured, then it will be a failure in the reverse. So that, particularly in this study that is something that you would want to talk a little bit about.

There were actually two articles that were done. All of this work was published in a series of meetings that came out of the International Symposium on Self-Directed Learning. The books were all published through the University of Oklahoma. The very first one was done in 1989 and published through the University of Georgia. Then Huey went on to Oklahoma and the Oklahoma Press picked up the publication. They are relatively hard to get a hold of. The best places to check actually would be to email University of Oklahoma, Department of Educational Leadership. They may be able to tell you about the books. Huey has retired to Florida. If you can not locate them, give me a call and I will try to locate my copies.

The other piece about the self-directedness is and I don't know how you are going to handle it and it something you need to have a conversation with your major advisor. The challenge you have with the term self-directedness is this, when you look across the literature in self-directedness it sort of divides itself into three basic chunks or frames. The first chunk is around the work that Cyril Houle did and then Alan Tough followed up with the adult learning project. So Houle's work on The Inquiring Mind is certainly a seminal case and then the adult learning project that Tough did set a stage for thinking about self-directed learning as learning projects. How do people complete learning projects? Learning as a classroom structure without the physical environment of the

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

classroom. That work started in 1961 with *Inquiring Mind* and ran all the way through middle to late 1970 with the adult learning project being a 1979 publication. We jump into the 1980s and it was still pretty involved but it started to wane for sort of the second phase of work on self-directedness. And that is the subject Guglielmino kicked off with her dissertation and it was around defining self-directedness. What does it mean to be self-directed? That is where she came up with the self-directed readiness instrument she calls Self-Directed Learning Readiness Scale (SDLRS). When you look at the work in that period, it talks about self-directedness and all that other stuff. Two pieces of work that pop up in that work, one is done by George Spear & Don Mocker in Adult Education Quarterly. There were two articles. One was done by Spear & Mocker called “The Organizing Circumstance”, which I think played directly on your theory because they talk about the condition of the environment and how people organize their own self learning. And the one that follows that is “Beyond the Organizing Circumstance”. And that would be another one you would want to read. You go through a whole period of how do you define these learners, what do these learners look like, and a little bit of how do you translate this into practical application in classrooms, in college situations, in business and industry and that is where you bang into Gerald Grow’s work. Then about 1993 there is a whole set of work around self-directedness that shifts defining self-directedness to more of the language of learner autonomy. It shows up in three places mostly. One is stuff that was done by Philippe Carré. It is kind of a European piece. Another piece of work was by Gerald Straka, and another contingent in Canada with Nicole Tremblay and Ron Fouchaux, and actually it was Bill Cox’s dissertation on what are the conditions and situations of people who engaged in self-directed learning kind of stuff. There was a whole bunch of work done here in the U.S. around learner autonomy; the problem with that stuff is that it never got published. It appears again in these symposiums, my husband; Gary Confessore did work around learner autonomy. The reason I am going through all of this is because you are operationally defining self-directed learning as locus of control, metacognitive skills, and motivation to learn. And that stuff needs to be mainlined back to the literature on self-directedness that gets you to those things. Actually, what I think you are going to find is that your metacognitive skills are probably not going to appear or if it does appear it will be very little around your metacognitive skills. Your self-directedness construct is going to need some more work to substantiate these three pieces that you chose. The place that you may find some work on metacognitive skills will be George Spear’s work, Spear & Mocker’s work. So that is why for comprehensiveness of your theory I gave you a 3.

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5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality			X		

Comments: This is a 3 and actually bears back to #4. I think you operational definitions within the context of self-directedness related to locus of control, metacognitive skills, and motivation to learn have to be done with a bit more precision. The definitions you use are from educational literature at large. They have that other context in there.

6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity				4	

Comments: I think there are all kinds of potential for turning this stuff into questions.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness				X	

Comments: There is lots of potential here for testing the propositions.

8. Please rate and comment on the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality				X	

Comments: I had a little bit of difficulty seeing the translation back. I was defining practicality as. I’m thinking about the way dissertations got done at TW when I was there. Basically, our practical connection back was how does this build your conceptual framework so that you have transferability across the range of places. The answer to that question is clearly there is transferability here. As I sat here looking at this I thought that this is interesting because we are in the middle of a massive training program and we are going to include CBI. And I am looking at this thing and I am thinking that it is really interesting as I think about my positions and where they are placed on all of this. The factors that you have here are clearly the ones that we are asking about from a theoretical perspective. So, I guess the answer is yes, the practicality of it is clearly there.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

9. Please comment on any other aspect of “A Theory of Effective Computer-Based Instruction for Adults” that has not been previously addressed.

All my comments are wrapped around the self-directedness piece. My overall sense of what you have done here is that you have done a very good piece of work and very interesting study. So I think it is a very good study.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

Evaluator: Dr. Steven Crooks

Title: Assistant Professor

Organization: Texas Tech University

Field of Research: Graphic & Verbal information on the computer, message design

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance				X	

Comments: The theory has a lot of importance. Pretty ambitious undertaking that you did pulling the material together that you did. Enjoyed reading the theory got some pretty good ideas. Quite interesting. Felt like when you start getting at all the attribute statements or interactions it gets pretty overwhelming and I think this is important and needs to be done.

- 2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity				X	

Comments: Gave it a high also. Felt it was quite clear. Only I had a question about and maybe I missed it, with the purpose of theory primarily descriptive or prescriptive or both. Were you trying to describe how and it clearly was there and also the other was

A Theory of Effective Computer-Based Instruction For Adults Scholarly Evaluation Form

there. Maybe a little discussion of the final outcome of the theory would be helpful. Reigeluth talks about two kinds of theory in instructional design, the first one being descriptive, in other words describing the learning process itself and it would be up to the practitioner to translate those descriptions into some kind of practical application of the theory. A lot of instructional design theories are prescriptive. They prescribe what action should be taken given a certain context situation. It seems like in your writing you had a little bit of both and clearly you can't have prescriptive theory unless it is based on some kind of descriptive theory. I just thought a little more clarity in terms of what is the purpose of the theory. It kind of related to the practicality below.

- 3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity			X		

Comments: It is a little bit of a dilemma. If you make something too parsimonious, you have bitten off a pretty big domain. Lots of issues and so forth. The more parsimonious you make it, you risk losing some explanatory value. It is kind of a catch 22. You want to be informative and to inform practice, at the same time then you want it to be simple. I am not so sure that that is bad to have a moderate rating. Difficult challenge especially when you have a broad field that you are trying to cover.

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Scholarly Evaluation Form

4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness				X	

Comments:

I thought it was quite comprehensive. Covered a lot of aspects. You pulled together a lot of pieces that I have seen in the literature in a comprehensive way. I thought that was one of the key things.

5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality				X	

Comments: There are a lot of potential prescriptions that can come out of this theory relating to learner control, program vs. learner control, also screen design, the type of learning outcome and how all of these things could inform practitioners. To the extent that the research is done properly and so forth. And the other side of the coin also, it informs research cause now people have some real practical variables to look at. I was thinking as I was going through that my students probably ought to read this to generate ideas for research. You have all kinds of attribute treatments issues to look at: self-efficacy, locus of control, motivation, metacognition and how they interact with and you prescribed some directions for which the research is pointing which I think is good. Undoubtedly, there are other issues. It is really hard to put you hand on everything. I ranked it high because I thought it very operational.

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Scholarly Evaluation Form

6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity					X

Comments: I see this directly related to #5. You have lot of studies generated from this model that could be easily turned in to hypothesis. Be confirmed by research. I had a hard time distinguishing between Question 6 and 7. I would rank it very high.

7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness					X

Comments:

I would rank it very high. One of the limitations probably is that you never quite know whether you have identified all the variables: locus of control, metacognitive skills, motivation, self-directedness, and self-efficacy. Others variables will undoubtedly emerge. It would definitely be fruitful because it will focus research efforts in this area to be tested. And other issues will arise and they will be modified, and so forth.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

- 8. Please rate and comment on the practicality of “A Theory of Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality			X		

Comments: I would actual like to have another diagram or two. Figure 2 is very good. Figure 2 is very descriptive. It is an important part of your theory and it describes input, processes, and output. To really inform practitioners, you have a lot of good material in the narrative about which kinds of instructional control or support would be appropriate for certain kinds of other personal variables. I think it would be interesting to see another figure that would pull together some of theses prescriptions, in other words a practitioner could pick it up and know quickly what to do in a given case. In other words if I have a very low level of skill to be taught in Bloom’s Taxonomy, then the prescription would be then to provide more program control than user or learner control, that sort of thing. Or based on someone that has high external locus of control, then they would needs some more external support in their instruction. Pull together more of the good narrative that you have in a simple way. Somewhere put in another figure to provide prescriptions would make it more practical. Having this to inform my practice. Not just at the conceptual level but at the practical level.

- 9. Please comment on any other aspect of “A Theory of Computer-Based Instruction for Adults” that has not been previously addressed.**

One thing would be to clarify the parameters of CBI. There is a lot of computer application that are more consistent with contemporary learning theories and I am thinking of simulation, full based scenarios, open learning environments, things like that. Is your theory focused more on the tutorial concept in other words CBI defined as a tutorial concept where you have information presentation, practice, feedback, examples, what we would call the traditional tutorial. It seems like lately, the last four or five years, we have seen a lot of people calling other things CBI too, like simulations or ultimate learning environments. I just did an advance instructional design class using Reigeluth’s instructional design text and he talks about a number of different applications. Maybe some clarification in terms of the parameters as to what you mean by CBI. I thought you did a good job and look forward to seeing the final product.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

Evaluator: Dr. Susan Gray

Title: Professor, Behavioral Sciences

Organization: New York Institute of Technology

Field of Research: latest research in this area was hypertext

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance				X	

Comments: Important to CBI but changes in technology limits the theory. Many situations are now hybrid. Something very controllable as compared to Blackboard. Some restrictedness to the situations.

- 2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity			X		

Comments: Some of the components there seem to be some overlap. Clarify the concepts so that they are more discrete. (Could not locate her notes concerning this question).

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

- 3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity			X		

Comments: There were places where there were arrows that were missing. Expected arrow between learning goal level and screen design. Also expected arrow between instruction strategy and learning outcome.

- 4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness					X

Comments: Had broad coverage.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality					X

Comments: Definitions were precise.

6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity				X	

Comments: Page 90 is flow chart of relationships. Clarity will come when propositions are developed. Hard to judge the way to set up without propositions. Is promising. Hard to rate. Gave a 4 based on the promise of the propositions but doesn't see it yet.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

- 7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.**

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness				x	

Comments: Lays out in systematic way. Organized relationships previously developed in literature. Potential fruitfulness. Gave a rating of 4 based on the promise of the propositions.

- 8. Please rate and comment on the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality				X	

Comments: If practicality is organization. Organized the relationship as in conceptual model. Highly practical.

- 9. Please comment on any other aspect of “A Theory of Effective Computer-Based Instruction for Adults” that has not been previously addressed.**

Found this very interesting and thought it had potential. Very different from the theory building I have seen in my area of behavioral science.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

Evaluator: Greg Kearsley

Title: Consultant

Organization: N/A

Field of Research: Online Learning/Teaching

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance		X			

Comments: The theory basically summarizes/synthesizes old research. While it's useful to have such a synthesis, it does really provide any major new explanations or predictions about computer based learning.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity				X	

Comments: Yes, it’s clear enough and seems consistent. I’m not sure about precision, though. Seems like the many hypotheses made could be more specific in terms of their implications for future design of CBI or its effectiveness. Figure 2 helps lay out the basic ideas.

3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity			X		

Comments: I kept wondering in reading through the “Units” section, how much of the literature mentioned was really relevant to the section and whether it would matter if it was left out. Does each unit really make the theory stronger or more robust?

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Scholarly Evaluation Form

- 4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness			X		

Comments: The construct analysis provides a basis for what should be covered in the theory. However, I have some qualms about coverage in terms of reference sources (see comments in section 9 below)

- 5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality		X			

Comments: I think that the hypotheses (laws) of the theory are stated in a form that they could operationally be tested or applied easily. The system states section is potentially the most valuable for organizational planning, but the implications of the states for the design and delivery of CBI needs to be elaborated.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity		X			

Comments: Because this is a metatheory, the validity of the hypothesis rests upon the studies analyzed for the constructs. Who knows how good they are? At least when you do a meta-analysis you get some measure of the variation.

7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness		X			

Comments:

Unless the hypotheses are put in a more operational form, I don’t see this work stimulating any further research. It would be useful as a synthesis of classic CBI work, but isn’t very relevant to current online learning research or practice.

A Theory of Effective Computer-Based Instruction For Adults

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- 8. Please rate and comment on the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality			X		

Comments:

The system states sections could be useful for organizational planning if the implications of the different states for making decisions about design and delivery were explained. Should take a look at the e-learning case studies published by Zane Berge – they describe CBI in various states that might match up to your analysis.

- 9. Please comment on any other aspect of “A Theory of Effective Computer-Based Instruction for Adults” that has not been previously addressed.**

1. Your sources don't include some online journals that are good sources of current research about online learning such as *J. Asynchronous Learning Networks* (<http://www.aln.org/alnweb/journal/jaln.htm>), *International Journal on E-Learning* – (<http://www.aace.org/pubs/ijel>), or *Technology Source* (<http://ts.mivu.org>). I mention this because the majority of your citations seem to be older literature (pre-1995 and before the web) which you would typically find in printed material. I think this is important because it shapes the definition of CBI and constructs that you are analyzing.

2. Related to the previous comment, I think you have a bit of a scope problem. You have defined CBI to include online, web-based learning. But you are mostly looking at older literature that pre-dates the web and all the new ways it is now being used in learning/training. Hence I would say that your theory primary covers “classic” CBI, before 1995 and the advent of modern online learning. For example, a major thrust of contemporary online learning is collaboration and social interaction, but this was not part of classic CBI.

A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form

3. You define adults as learners over 18 years of age. But that would include undergrads and they certainly don't behave much like adult learners. The corpus of adult learning theory was basically developed for working, post-college adults. What characterizes the adult learner is having to balance work, family, and personal life with learning. So, I'd recommend you define as post-undergrad, or at least 25 years old.
4. By basing your theory on constructs derived from other research, you are really developing a meta-theory (2nd order theory). The data you examining is not from subjects, but research studies. A meta-theory is different in nature from a theory in so far as it tries to synthesize research findings rather than directly account for empirical results.
5. As you discuss the units of the theory, you often discuss general findings about learning then draw some conclusions in the context of CBI, even though the findings have nothing to do with CBI. It's ok to speculate about the relationship of such findings to CBI, but in most cases you assert the conclusion...which is faulty.
6. I don't think you want to use the term "laws" for your hypothesized interactions – that suggests that these are well validated principles (like the laws of mechanics or thermodynamics). I'd suggest you call them what they are – hypotheses...or at least "hypothesized laws".
7. I was surprised not to see any mention of the work of Banathy or Reigeluth, two prominent education system theorists in your system states work. Since this is potentially the most valuable part of your theory, I would think that you want to take advantage of past work in this area. Speaking of which, I assume that in the preceding chapters there is some discussion of others who have proposed theoretical frameworks for CBI such as Badrul Khan, Andy Gibbons & Peter Fairweather, or Roger Schank. I can't imagine developed a theoretical framework of CBI without some discussion of other theoretical efforts.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

Evaluator: Dr. George A. Marcoulides

Title: Professor

Organization: California State University, Fullerton

Field of Research: computer anxiety, student performance

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance					X

Comments: The first question that I have is that in your definition of effective, your theory of effective CBI it is not clear to me what you effect. So my question is as measured by what? Effective anything, so I made an assumption there of what I consider to be effective CBI. So I rate importance as very high with my own interpretation of effective CBI for adults. If effective, one achieves some specified set of learning outcomes, I guess. I am assuming that is what you are implying by your definition of effective. One can still have a theory of CBI period without it being effective or ineffective. In other words, the theory, I was somewhat confused of why the need of effective, it is simply a theory of CBI for adults whether it is effective or not it is simply a by-product of whether or not one achieves the particular learning outcomes. Clearly, I think it is very important. You wouldn't take away for this theory if you just talk about it as a theory of CBI for adults.

**A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form**

2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
2	Precision and Clarity					X

Comments: NONE

3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
3	Parsimony or Simplicity					X

Comments: When I answer this one my comments also apply to #4.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
4	Comprehensiveness				X	

Comments: My comments have to do with my belief that there is no theory that one can put on paper that proposally model the richness of reality. So, you are bound to sort of have some limitation, so comprehensiveness is again relative. I think within the definition you have given me, whether it completely covers the area of interest, the answer is no it does not completely cover the area of interest. It is a focus on the particular aspect of reality. Is it close to simplicity? Yes it is simplistic because you can actually make sense out of what is perhaps may be a very fuzzy presentation of reality. Any time you try to dive into modeling reality, I think you are bound to exclude some aspect of it. Is that a limitation of your theory, no I think it is a limitation of almost any attempt to model reality. I don't think you will ever be able to be fully comprehensive.

5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
5	Operationality				X	

Comments: Again it has to do more with specificity some of the aspects of the components of the theory. Some of the aspects of the theory are not always amenable to the direct operationalization. We think we know what we are talking about but it is not always necessarily easy to tap into.

A Theory of Effective Computer-Based Instruction For Adults

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6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
6	Empirical Validity					X

Comments: Basically you have an apriori proposed theory then once you have done that, then ones ability to test the theory is very straight forward. All you need to do is to ensure that you collect the appropriate data. I think empirical validation is a natural follow up once an apriori proposed theory is placed on paper.

7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory’s propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.

Rating criteria(see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
7	Fruitfulness					X

Comments: I will clarify my response based on how clearly one can delineate learning outcomes. Sometimes those learning outcomes are not as straight forward as those that you used and would have a slightly lower rating. However, for those that you used I would rate a 5.

A Theory of Effective Computer-Based Instruction For Adults

Scholarly Evaluation Form

- 8. Please rate and comment on the practicality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.**

Rating criteria (see attached criteria):						
		1 very low	2 low	3 moderate	4 high	5 very high
8	Practicality					X

Comments: Once in fact we have some theory and understanding of this purpose of CBI, one can actual model training programs to improve, increase, or develop what ever these learning outcomes are that one specifies. I think it is an extremely important theory to have available and to have one that to date has not really comprehensively been put on paper.

- 9. Please comment on any other aspect of “A Theory of Effective Computer-Based Instruction for Adults” that has not been previously addressed.**

The originality of the theory, I think clearly in the literature that I know of, no one has ever really brought to fruition all the various aspects of the design and the various processing steps that occurred. And so I see this as a very unique and comprehensive attempt to look at CBI not only for adults. I know you talked about adults but I think all CBI.

The natural extension of this would be to obtain specific measures of locus of control, self-directedness, motivation and actually examine the direct magnitude of the effect so that you can then walk in and say that people have this perspective in terms of level of motivation to learn and this degree of self-efficacy given that there are so many scales of self-efficacy out there it would not be difficult to do. To collect data and actually determine the precise contribution of each of these aspects. So that you can create approaches to establishing specific learning outcomes for various groups. If someone walk in the door and you have a specific measure on their locus of control, or self-efficacy or what ever aspect you are looking into then you can make adjustments to what it is that can be done within the environment in order to ensure that everyone that leaves the door with the same learning outcomes assuming that is the goal of the final program. I think it is very exciting and there is a natural to it. The next important step would be how different is this particular theory for adults and for others. Younger children and

A Theory of Effective Computer-Based Instruction For Adults
Scholarly Evaluation Form

what age would it change. Is it uniform across cultures, is it uniform, I can think of so many subdivisions of the practicality of the theory and at the same time what I would call external validity. By how much does this theory change depending on which group of people we are looking at. Also, are there aspects you haven't considered, for example experience. Does that make a difference? If so, where does it fit into the general framework? Those of us who are peripherally involved in the field will greatly benefit from your dissertation and hopefully, in the years to come you will take it further.

APPENDIX C
LIST OF ARTICLES USED FOR CONSTRUCT ANALYSIS
BY AUTHOR AND TITLE

LIST OF ARTICLES USED FOR CONSTRUCT ANALYSIS BY AUTHOR AND TITLE

List of Articles Used for Construct Analysis by Author and Title						
Article #	Date	Author	Author	Author	Author	Title of Article
103	1994	Ahern, T. C.	Repman, J.			The Effects of Technology on Online Education
9	1985	Allen, B. S.	Merrill, M. D.			System-Assigned Strategies and CBI
171	1988	Allred, K. F.	Locatis, C.			Research, Instructional Design, and New Technology
65	1990	Arthur, Winfred	Hart, Darren			Empirical Relationships Between Cognitive Ability and Computer Familiarity
157	1991	Aspillaga, M.				Screen Design: Location of Information and Its Effects on Learning
107	1995	Astlertner, H.	Keller, J. M.			A Model for Motivationally Adaptive Computer-Assisted Instruction
104	1980	Avner, Allen	Moore, Carolyn	Smith, Stanley		Active External Control: A Basis for Superiority of CBI
184	1996	Ayersman, David J.				Reviewing the Research on Hypermedia-Based Learning
185	1995-96	Ayersman, David J.	Reed, W. M.			Effects of Learning Styles, Programming, and Gender on Computer Anxiety
71	1991	Baack, S. A.	Brown, T. S.	Brown, J. T.		Attitudes Toward Computers: Views of Older Adults Compared with Those of Young Adults
94	1992	Baird, W. E.	Silverin, S. B.			Computer Learning and Appropriate Testing: A First Step in Validity Assessment
44	1997	Barab, S. A.	Bowdish, B. E.	Lawless, K. A.		Hypermedia Navigation: Profiles of Hypermedia Users
88	1991	Barrett, H. C.				Adult Self-Directed Learning, Personal Computer Competency, and Learning Style: Models for More Effective Learning
51	1986	Batte, M. T.	Fiske, J. R.	Taylor, R. D.		Assessing the Concept of Computer Literacy: A Case Evaluation in the College of Agriculture
176	1993	Beard, Charles H.				Transfer of Computer Skills from Introductory Computer Courses
33	1985	Belland, J. C.	Taylor, W. D.	Canelos, J.	Dwyer, F.	Microcomputer-Based Instruction, the Most Effective Method of Addressing Individual
116	1979	Berkowitz, M. S.	Szabo, M.			Computer-Based Inquiry into Scientific Problem Solving
135	1992	Billings, D. M.	Cobb, K. L.			and GPA on Learner Achievement Using Computer Assisted Interactive Videodisc
178	1981	Boettcher, E. G.	Alderson, S. F.	Saccucci, M. S.		Assisted Instruction Versus Printed Instruction on Student Learning in the Cognitive Categories
40	1982	Bonner, J.				Systematic Lesson Design for Adult Learners
186	1995	Bowman, B. J.	Grupe, F. H.	Simkin, M. G.		Based Training: Theory and an Empirical Investigation
187	1997	Bratton-Jeffery M. F.				An Information-Processing Model as a Metacognitive Strategy: Its Effects on Performance in a Military Computer-Based Training Environment
188	1994	Brock, D. B.	Sulsky, L. M.			Attitudes Toward Computers: Construct Validation and Relations to Computer Use
167	1985	Burger, K.				Computer Assisted Instruction: Learning Style and Academic Achievement
59	1989	Byrd, D. M.	Koohang, A. A.			Computer Experience Associated with Subjects' Attitudes Toward the Perceived Usefulness of
4	1985	Cambre, M. A.	Cook, D. L.			Computer Anxiety: Definition, Measurement, and Correlates
95	1992	Campbell, N. J.				Students: Computer Proficiency, Attitudes, and Attributions

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Article #	Date	Author	Author	Author	Author	Title of Article
170	1991	Carlson, H. L.				Learning Style and Program Design in Interactive Multimedia
134	1992	Carlson, R. D.	Grabowski, B. L.			Direction-Following Behavior in Computer Assisted Instruction
2	1993	Carlson, R. E.	Wright, D. G.			Computer Anxiety and Communication Apprehension: Relationship and Introductory College Course Effects
149	2002	Chisholm, I. M.	Carey, J.	Hernandez, A.		Information Technology Skills for a Pluralistic Society: Is the Playing Field Level?
148	2002	Christensen, R.				Effects of Technology Integration Education on the Attitudes of Teachers and Students
159	1993	Clariana, Roy B.				A Review of Multiple-Try Feedback in Traditional and Computer-Based Instruction
41	1984	Clark, R. E.				Research on Student Thought Processes During Computer-Based Instruction
12	1985	Collet, L. S.	Shiffler, N. L.			A Computer Simulation Approach to Teaching Research and Evaluation Skills
151	2002	Compeau, D.				The Role of Trainer Behavior in End User Software Training
117	1983	Conklin, D. N.				A Study of Computer-Assisted Instruction in Nursing Education
144	2000	Cook, K. C.				Instructional Design, and Student Preference in Internet-Based Distance Education
193	1991	Cowen, Michael				The Role of Feedback in Computer-Based Training
26	1978	Crawford, A. M.	Crawford, K. S.			Simulation of Operational Equipment with a Computer-Based Instructional System: A Low Cost Training Technology
80	1996	Crooks, S. M.	Klein, J. D.	Jones, E. E. K.	Dwyer, H.	Effects of Cooperative Learning and Learner-Control Modes in Computer-Based Instruction
99	1993-94	Croy, M. J.	Cook, J. R.	Green, M. G.		Human-Supplied Versus Computer-Supplied Feedback: An Empirical and Pragmatic Study
67	1992	Davidson, G. V.	Savenye, W. C.	Orr, K. B.		How Do Learning Styles Relate to Performance in a Computer Applications Course?
28	1984	Davis, B. L.	Mount, M. K.			Using Computer Assisted Instruction and Behavior Modeling
98	1993	Delclos, V. R.	Hartman, A.			on the Quality of Learning in Educational Psychology: An Exploratory Study
177	1979	Dennis, V. E.				on Correct Responses, Trials, Total Instructional Time and Response Latency in a Computer-Based
49	1998	Dillon, A..	Gabbard, R.			Review of the Quantitative Research Literature on Learner Comprehension, Control, and Style
114	1977	Dixon, P. N.	Judd, W. A.			A Comparison of Computer-Managed Instruction and Lecture Mode for Teaching Basic Statistics
29	1983	Dossett, D. L.	Hulvershorn, P.			Increasing Technical Training Efficiency: Peer Training via Computer-Assisted Instruction
128	1990	Duin, A. H.				Computer Documentation - Centering on the Learner
75	1994	Ertmer, P. A.	Evenbeck, E.	Cennano, K. S.	Lehman, J. D.	Technologies Through The Use of Positive Classroom Experiences
108	1982	Federico, P-A.				Characteristics and Computer-Managed Mastery Learning

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118	1983	Federico, P-A.				Changes in the Cognitive Components of Achievement as Students Proceed Through Computer-Managed Instruction
101	1993-94	Fogarty , T. J.	Goldwater, P. M.			System: An Academic Accounting Innovation and Field Test
115	1979	Forsythe, A. B.	Freed, J. R.			An Evaluation of Computer-Aided Instruction in an Introductory Biostatistics Course
73	1995	Freitag, E. T.	Sullivan, H. J.			Instruction: An Alternative Form of Learner Control
168	1986	Garhart, C.	Hannafin, M. J.			The Accuracy of Cognitive Monitoring during Computer-Based Instruction
141	1981	Gaynor, P.				The Effect of Feedback Delay on Retention of Computer-Based Matematical Material
126	1989	Grabe, M.	Petros, T.	Sawler, B.		An Evaluation of Computer-Assisted Study in Controlled and Free Access Settings
191	1993	Grabinger, R. Scott				Computer Screen Designs: Viewer Judgments
3	1989	Gray, S. H.				The Effect of Locus of Control and Sequence Control on Computerized Information Retrieval and Retention
109	1988	Gray, S. H.				Sequence Control Menus and CAI: A Follow-Up Study
110	1987	Gray, S. H.				The Effect of Sequence Control on Computer Assisted Learning
166	1992	Guthrie, B. M.	McPherson, M.			The Efficacy of a Customized Approach to Computer Assisted Instruction
130	1991	Hannafin, M. J.	Carney, B. W.			Depth of Processing During Computer-Based Instruction
42	1984	Hannafin, M. J.				Control in the Design of Computer-Assisted Instruction
7	1990	Harrington, K. V.	McElroy, J. C.	Morrow, P. C.		Computer Anxiety and Computer-Based Training: A Laboratory Experiment
194	1994	Harris, James E., Jr.				A Meta-Analysis of the Effectiveness of Feedback in Computer-Based Instruction for Adults
39	2000	Herrington, J.	Oliver, R.			An Instructional Design Framework for Authentic Learning Environments
85	1992	Hicken, S.	Sullivan, H. J.	Klein, J. D.		Learner Control Modes and Incentive Variations in Computer-Delivered Instruction
68	1992	Hignite, M. A.	Echternacht, L. J.			Computer Attitudes and Computer Literacy Levels of Prospective Educators
45	1997	Hill, J. R.	Hannafin, M. J.			Cognitive Strategies and Learning from the World Wide Web
162	1985	Hofstetter, F. T.				Perspectives on a Decade of Computer-Based Instruction, 1974-84
54	1987	Honeyman, D. S.	White, W. J.			Computer Anxiety in Educators Learning to Use the Computer: A Preliminary Report
125	1989	Hooper, S.	Ward, T.	Hannafin, M. J.	Clark, H. T.	The Effects of Aptitude Composition on Achievement During Small Group Learning
96	1993	Hunt, N. P.	Bohlin, R. M.			Teacher Education Students' Attitudes Toward Using Computers

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11	1985	Hythecker, V. I.	Rocklin, T. R.	Dansereau, D. F.	Lambiotte, J. G.	A Computer-Based Learning Strategy Training Module: Development and Evaluation
138	1993	Janniro, M. J.				Effects of Computer-Based Instruction on Student Learning of Psychophysiological Detection of Deception Test Question Formulation
146	2002	Jawahar, I. M.				The Influence of Dispositional Factors and Situational Constraints on End User Performance: A Replication and Extension
152	2001	Jawahar, I. M.	Elango, B.			The Effect of Attitudes, Goal Setting and Self-Efficacy on End User Performance
161	1993	Jonassen, D. H.	Wilson, B. G.	Wang, S.	Grabinger, R. S.	Constructivist Uses of Expert Systems to Support Learning
112	1976	Jones, L. A.	Sorlie, W. E.			Increasing Medical Student Performance with an Interactive, Computer-Assisted Appraisal System
86	1999	Jones, T. H.	Paolucci, R.			Evaluating the Effectiveness of Educational Technology Systems on Learning Outcomes
102	1994	Jones, W. P.				Computer Use and Cognitive Style
89	1998	Karsten, R.	Roth, R. M.			Computer Self-Efficacy to Performance in Introductory Computer Literacy Courses
58	1989	Kay, R. H.				Gender Differences in Computer Attitudes, Literacy, Locus of Control and Commitment
60	1989	Kay, R. H.				A Practical and Theoretical Approach to Assessing Computer Attitudes: The Computer Attitude Measure (CAM)
66	1990	Kay, R. H.				The Relation Between Locus of Control and Computer Literacy
129	1992	Kay, R. H.				Understanding Gender Differences in Computer Attitudes, Aptitude, and Use: An Invitation to Build Theory
113	1977	Kearsley, G. P.				Some Conceptual Issues in Computer-Assisted Instruction
158	1982	Kearsley, G. P.	Hillelsohn, M. J.			Human Factors Considerations for Computer-Based Training
81	1996	Kellenberger, D. W.				Efficacy Based on Achievement and Value Beliefs Within a Motivational Framework
143	1988	Kern, G. M.	Matta, K. F.			The Influence of Personality on Self-Paced Instruction
147	2002	Kim, B.	Williams, R.	Dattilo, J.		Students' Perception of Interactive Learning Modules
10	1990	Kinzie, M. B.				Requirements and Benefits of Effective Interactive Instruction: Learner Control, Self-Regulation, and Continuing Motivation
183	1990	Kinzie, M. B.	Berdel, R. L.			Design and Use of hypermedia systems
77	1994	Klein, J. D.	Pridemore, D. R.			Achievement, Continuing Motivation, and Student Behaviors in a Cooperative Learning Environment
97	1993	Klein, J. D.	Knupfer, N. N.	Crooks, S. M.		Differences in Computer Attitudes and Performance Among Re-entry and Traditional College Students

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34	1987	Koohang, A. A.				A Study of the Attitudes of Pre-Service Teachers Toward the Use of Computers
61	1989	Koohang, A. A.				A Study of Attitudes Toward Computers: Anxiety, Confidence, Liking, and Perception of Usefulness
76	1994	Kumar, D. D.	Helgeson, S. L.	White, A. L.		Computer Technology-Cognitive Psychology Interface and Science Performance Assessment
79	1996	Land, S. M. .	Hannafin, M. J.			A Conceptual Framework for the Development of Theories-in-Action with Open-Ended Learning Environments
16	1992	Leso, T.	Peck, K. L.			Computer Anxiety and Different Types of Computer Courses
127	1990	Litchfield, B. C.	Driscoll, M. P.	Dempsey, J. V.		Their Effect on Concept and Rule Learning in Computer-Based Instruction
69	1992	Liu, M.	Reed, W. M.	Phillips, P.		Gender, Major, Prior Computer Experience, Occurrence, and Anxiety
182	2001	Lou, Yiping	Abrami, Philip C.	d'Apollonia, S.		Small Group and Individual Learning with Technology: A Meta-Analysis
53	1986	Loyd, B. H.	Gressard, C. P.			Teachers in Staff Development Programs: Effects on Computer Attitudes and Perceptions of the
123	1989	Mahmood, M. A.	Medewitz, J. N.			Subjects' Attitudes, Values, and Opinions Toward Information Technology: An Exploratory Longitudinal Investigation Using the Linear
105	1994-95	Marcinkiewicz, H. R.				Differences in Computer Use of Practicing Versus Preservice Teachers
6	1990	Marcoulides, G. A.				Improving Learner Performance with Computer Based Programs
14	1988	Marcoulides, G. A.				The Relationship Between Computer Anxiety and Computer Achievement
52	1986	Marshall, J. C.	Bannon, S. H.			Computer Attitudes and Computer Knowledge of Students and Educators
5	1991	Massoud, S. L.				Computer Attitudes and Computer Knowledge of Adult Students
64	1990	Massoud, S. L.				Factorial Validity of a Computer Attitude Scale
100	1993-94	Maurer, M. M.	Simonson, M. R.			to Relaxation Training, Previous Computer Coursework, Achievement, and Need for
43	1981	McCombs, B. L.				Practice: Focus on the Student in Technical Training
121	1983	McDonald, B. A.	Crawford, A. M.			Remote Site Training Using Microprocessors
70	1992	McGrath, D.				Hypertext, CAI, Paper, or Program Control: Do Learners Benefit From Choices?
131	1991	Milheim, W. D.	Martin, B. L.			Theoretical Bases for the Use of Learner Control: Three Different Perspectives
87	2000	Mitra, A.	Steffensmeier, T.			Computer Use in a Computer-Enriched Environment
181	1983	Montague, W. E.	Wulfeck, W. H.	Ellis, J. A.		Quality CBI Depends on Quality Instructional Design and Quality Implementation
120	1983	Morrison, J. E.	Witmer, B. G.			A Comparative Evaluation of Computer-Based and Print-Based Job Performance Aids

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140	1985	Munro, A.	Fehling, M. R.	Towne, D. M.		Instruction Intrusiveness in Dynamic Simulation Training
83	1989	Newby, R. J.	Alter, P. A.			Task Motivation: Learner Selection of Intrinsic versus Extrinsic Orientations
172	1993	Olivier, R. A.	Shapiro, F.			Self-Efficacy and Computers
78	1993	Orey, M. A.	Nelson, W. A.			Systems: Integrating Cognitive Theory into the Development of Computer-Based Instruction
150	2001	Orr, Claudia	Allen, David	Poindexter, Sandra		The Effect of Individual Differences on Computer Attitudes: An Empirical Study
106	1994-95	Overbaugh, R. C.	Reed, W. M.			Specific Computer Course on Computer Anxiety and States of Concern
192	1993	Park, I.	Hannafin, M. J.			Empirically-Based Guidelines for the Design of Interactive Multimedia
82	1995-96	Perkins, R. F.				Using Hypermedia Programs to Administer Tests: Effects on Anxiety and Performance
119	1983	Pohlman, D. L.	Edwards, B. J.			Desk Top Trainer: Transfer of Training of an Aircrew Procedural Task
1	1993	Premkumar, G.	Ramamurthy, K.	King, W. R.		Computer Supported Instruction and Student Characteristics: An Experimental Study
38	1991	Pridemore, D. R.	Klein, J. D.			Control of Feedback in Computer-Assisted Instruction
189	2001	Ratcliff, M. E.				Sequencing: An Examination of the Relationship Between Two Instructional Delivery Systems and the Acquisition and Application of Subject Matter
92	1997	Reed, W. M.	Oughton, J. M.			Computer Experience and Interval-Based Hypermedia Navigation
174	1993	Reeves, Thomas D.				Pseudoscience in Computer-Based Instruction: The Case of Learner Control Research
165	1979	Reigeluth, C. M.				TICCIT to the Future: Advances in Instructional Theory for CAI
122	1989	Reigeluth, C. M.	Schwartz, E.			An Instructional Theory for the Design of Computer-Based Simulations
48	1982	Reiser, R. A.	Gagné, R. M.			Characteristics of Media Selection Models
153	1990	Rieber, L. P.	Boyce, M. J.	Assad, C.		The effects of Computer Animation on Adult Learning and Retrieval Tasks
160	1990	Rieber, L. P.				Animation in Computer-Based Instruction
23	1976	Roe, M. H.	Aiken, R. M.			A CAI Simulation Program for Teaching IRI Techniques
91	1999	Ropp, M. M.				with Learning to Use Computers in Preservice Teacher Preparation
84	1989	Ross, S. M.	Morrison, G. R.	O'Dell, J. K.		Uses and Effects of Learner Control of Context and Instructional Support in Computer-Based Instruction

LIST OF ARTICLES USED FOR CONSTRUCT ANALYSIS BY AUTHOR AND TITLE

List of Articles Used for Construct Analysis by Author and Title						
Article #	Date	Author	Author	Author	Author	Title of Article
35	1988	Ross, S. M.	Morrison, G. R.	O'Dell, J. K.		Obtaining More Out of Less Text in CBI: Effects of Varied Text Density Levels as a Function of Learner Characteristics and Control Strategy
169	1981	Rushinek, A.	Rushinek, S. F.	Stutz, J.		The Effects of Computer Assisted Instruction Upon Computer Facility and Instructor Ratings
164	1991	Rysavy, S. D. M.	Sales, G. C.			Cooperative Learning in Computer-Based Instruction
57	1988	Sales, G. C.	Williams, M. D.			The Effect of Adaptive Control of Feedback in Computer-Based Instruction
156	1985	Salisbury, D. F.	Richards, B. F.	Klein, J. D.		and Recommendations from Instructional Design Theories
179	1990	Salisbury, D. F.				Designing Drill and Practice Programs for Computers
137	1992	Santiago, R. S.	Okey, J. R.			The Effects of Advisement and Locus of Control on Achievement in Learner-Controlled Instruction
13	1988	Schloss, P. J.	Wisniewski, L. A.	Cartwright, G. P.		Feedback in College Students' Performance on CAI Modules
55	1988	Schloss, P. J.	Sindelar, P. T.	Cartwright, G. P.	Smith, M. A.	Learner Control Over Feedback as a Variable in Computer-Assisted Instruction
37	2000	Schnackenberg, H. L.	Sullivan, H. J.			Learner Control Over Full and Lean Computer-Based Instruction Under Differing Ability Levels
46	1998	Schnackenberg, H. L.	Sullivan, H. J.	Leader, L. F.	Jones, E. E. K.	Learner Preferences and Achievement Under Differing Amounts of Learner Practice
18	1999	Schulman, A. H.	Sims, R. L.			Learning in an Online Format versus and In-class Format: An Experimental Study
21	1966	Schwartz, H. A.	Haskell, R. J.			A Study of Computer-Assisted Instruction in Industrial Training
20	1967	Schwartz, H. A.	Long, H. S.			A Study of Remote Industrial Training via Computer-Assisted Instruction
190	1997	Seyler, D. L.				Factors Affecting Motivation to Use Computer-Based Training
27	1992	Shaw, D. S.				Computer-Aided Instruction for Adult Professionals: A Research Report
8	1990	Shlechter, T. M.				The Relative Instructional Efficiency of Small Group Computer-Based Training
180	1992	Shlechter, T. M.	Bessemer, D. W.	Kolosh, K. P.		Playing: An Effective Combination for Fostering Conditional Knowledge
142	1987	Sizemore, M. H.	Pontious, S.			CAI Promotes Nursing Student Mastery of Health History Taking
24	1974	Skavari, R. V.				Computer-Based Instruction of Introductory Statistics
15	1986	Steinberg, E. R.	Baskin, A. B.	Hofer, E.		Organizational/Memory Tools: A technique For Improving Problem Solving Skills
50	1983	Steinberg, E. R.				Problem Complexity and the Transfer of Strategies in Computer-presented Problems
30	1992	Stephenson, S. D.				Training: A Review with Implications for Distance Learning
31	1992	Stephenson, S. D.				Achievement in a Dyad Computer-Based Training Environment
32	1991	Stephenson, S. D.				The Effect of Instructor-Student Interaction on Achievement in Computer-Based Training
136	1992	Stephenson, S. D.				Paired/Individual Study on Achievement in Computer-Based Training (CBI)
163	1988	Stokes, M. T.	Halcomb, C. G.	Slovacek, C. P.		Delaying User Responses to Computer-Mediated Test Items Enhances Test Performance
145	2003	Stone, R. W.	Henry, J. W.			The Roles of Computer Self-Efficacy and Outcome Expectancy in Influencing the Computer End-User's Organizational Commitment

LIST OF ARTICLES USED FOR CONSTRUCT ANALYSIS BY AUTHOR AND TITLE

List of Articles Used for Construct Analysis by Author and Title						
Article #	Date	Author	Author	Author	Author	Title of Article
22	1976	Swigger, K. M.				Automated Flanders Interaction Analysis
90	1999	Takacs, J.	Reed, W. M.	Wells, J. G.	Dombrowski, L. A.	Development, Learning Style, and Prior Computer Experiences on Teachers' Attitudes
173	1979	Tennyson, R. D.	Rothen, W.			Management of Computer-Based Instruction: Design of an Adaptive Control Strategy
154	1990	Tessmer, Martin				Environment Analysis: A Neglected Stage of Instructional Design
155	1990	Tessmer, Martin	Wedman, J. F.			A Layers-of-Necessity Instructional Development Model
25	1979	Trollip, S. R.				The Evaluation of a Complex Computer-Based Flight Procedures Trainer
19	1977	Tsai, S-Y. W.	Pohl, N. F.			Student Achievement in Computer Programming: Lecture vs. Computer-Aided Instruction
72	1991	Turnipseed, D. L.	Burns, O. M.			Contemporary Attitudes Toward Computers: An Explanation of Behavior
74	1994	Ullmer, E. J.				Media and Learning: Are There Two Kinds of Truth?
132	1991	van den Berg, S.	Watt, J. H.			Effects of Educational Setting on Student Responses to Structured Hypertext
47	1972	Van Dyke, B. F.	Newton, J. M.			Computer-Assisted Instruction: Performance and Attitudes
62	1989	Violato, Claudio	Marini, Anthony	Hunter, William		Model of Attitudes Toward Computers: A Study of Preservice Teachers
36	1986	Wager, W.				CAI for the Teaching of Typing Skills to Radio-Teletypewriter Operators
17	1991	Watson, W. E.	Behnke, R. R.			Application of Expectancy Theory and User Observations in Identifying Factors which Affect Human Performance on Computer Project
139	1985	Wesley, B. E.	Krockover, G. H.	Hicks, C. R.		Locus of Control and Acquisition of Computer Literacy
111	1974	White, A. L.	Smith, D. D.			Responsibility for Instructional Decisions in a CAI Course
133	1991	White, J. A.	Troutman, A. P.	Stone, D. E.		Effects of Three Levels of Corrective Feedback and Two Cognitive Levels of Tasks on Performance in Computer-Directed Mathematics instruction
124	1989	Whiteside, M. F.	Lang, N. P.	WhitesideJ. A.		Medical Students' Attitudes Tward the Use of Microcomputers as Instructional Tools
63	1989	Wu, Y-K.	Morgan, M.			Computer Use, Computer Attitudes, and Gender: Differential Implications of Micro and Mainframe Usage Among College Students
175	2000	Yildirim, Soner				Preservice and Inservice Teachers: A Discussion and Analysis of Attitudes and Use
56	1988	Yuen, S. C-Y.				How Vocational Teachers Perceive Microcomputers in Vocational Education
93	1998	Zhang, Y.	Espenoza, S.			Relationships Among Computer Self-Efficacy, Attitudes Toward Computers, and Desirability of Learning Computing Skills

APPENDIX D
EVALUATION PACKAGE

**INSTRUCTIONS FOR EVALUATION OF
“A THEORY OF EFFECTIVE COMPUTER-BASED INSTRUCTION FOR
ADULTS”**

- Please read “A Theory of Effective Computer-Based Instruction for Adults” found in Chapter 4 beginning on page 89-136 and Criteria for Evaluating Theory found in the attached documents.
- Also included is a set of questions with rating scale intended to serve as a guide for your evaluation of “A Theory of Effective Computer-Based Instruction for Adults.” Please review these prior to the telephone interview. If you wish to respond in writing, please send your response to me by email at jlowe61@cox.net prior to the telephone interview. If you wish to send responses to me by mail, the address is 395 College Hill Drive, Baton Rouge, LA 70808.
- If you wish to write comments directly on “A Theory of Effective Computer-Based Instruction for Adults” document please mail to the address above.
- A telephone interview time will be arranged prior to the week of November 10, 2003.
- All evaluations will be reviewed and serve as the basis for modifying “A Theory of Effective Computer-Based Instruction for Adults.” Once modifications are made, a copy of the final theory will be mailed to you.
- If you have any questions, I can be reached by email at jlowe61@cox.net during the day and at (225) 767-6363 after 5:00 p.m. during the week and on weekends.

CRITERIA FOR EVALUATING THEORY

Without the empirical testing of a theory, theories cannot be evaluated as to their correctness or validity. A theory may be good without being totally correct. However, a good theory is more likely to be true than a poor one. Patterson's eight criteria for evaluating theory is appropriate for the evaluation of "A Theory of Computer-Based Instruction for Adults" because:

- They were developed as criteria for evaluating theory in the behavioral sciences
- These criteria reflect a high degree of overlap among all the criteria from the six sources reviewed (Torraco, 1994)
- These criteria best represent the attributes the author seeks in "A Theory of Effective Computer-Based Instruction for Adults."

Patterson's (1986, p. xx) eight criteria for evaluating theory are to be used in this study with the following explanations:

1. Importance - a quality or aspect of having great worth or significance; acceptance by competent professional may be indicative of importance. A theory should not be trivial but should be significant. It should be applicable to more than a limited restricted situation. It should have some relevance to life. Importance is very difficult to evaluate since the criteria are vague or subjective. Acceptance by competent professionals or recognition and persistence in the professional literature may be indicative of importance. If theory meets other formal criteria, it is probably important.
2. Preciseness and Clarity - a state of being clear; hypotheses or predictions can easily be developed from the theory. A theory should be understandable, internally consistent, and

free from ambiguities. Clarity may be tested by the ease of relating the theory to data or practice. The easy of developing the hypotheses is another way of testing clarity.

3. Parsimony or Simplicity - uncomplicated; minimal complexity and few assumptions. Parsimony has long been accepted as a characteristic of a good theory. A good theory contains a minimum of complexity and few assumptions. The phenomena of the world and of nature are relatively simple in terms of basic principles. The law of parsimony appears to be the most widely violated in theory construction because of the stage of knowledge the theorist has reached, where diversity and complexity are more apparent than are the underlying unity and consistency. Hall and Lindzey (1970) propose that parsimony is important only after the criteria of comprehensiveness and verifiability have been met.
4. Comprehensiveness - covering completely or broadly; covering the areas of interest related to computer-based instruction and adults. A theory should be complete, covering the area of interest and including all known data in the field. The area of interest can be restricted.
5. Operationality - precise enough to be testable and measurable. A theory should be capable of being reduced to procedures for testing its propositions or predictions. Its concepts must be precise enough to be measurable. A lack of measurement to operationalize a concept should not rule out the use of a concept that is essential for a theory. The concept first should be defined and then a method of measurement chosen or developed. Not all concepts of a theory need to be operational; concepts may be used to indicate relationships and organization among concepts.

6. Empirical Validity or Verifiability - able to be confirmed or substantiated; experiments and experience that confirm or disconfirm the theory generate new knowledge. A theory must be supported by experience and experiments that confirm the theory. In addition to its consistency with or ability to account for what is already known, it must generate new knowledge. A theory that is disconfirmed by experiment may lead indirectly to new knowledge by stimulating the development of a better theory.
7. Fruitfulness - predictions are made that can be tested that lead to the development of new knowledge; development of new knowledge is considered fruitful. The capacity of a theory to lead to predictions that can be tested, when in turn leads to the development of new knowledge, has often been referred to as its fruitfulness. A theory can be fruitful even if it is not capable of leading to specific predictions. It may provoke thinking and the development of new ideas or theories because it leads to disbelief or resistance in others.
8. Practicality - provides a conceptual framework for practice. The final criterion of a good theory is its usefulness to practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles. Practitioners too often think of theory as something that is irrelevant to what they do, unrelated to practice or to real life. There is nothing as practical as a good theory (Lewin, 1951).

**QUESTIONS FOR EVALUATING
“A THEORY OF EFFECTIVE COMPUTER-BASED INSTRUCTION
FOR ADULTS”**

Do I have your permission to tape record this telephone interview to evaluate “A Theory of Effective Computer-Based Instruction for Adults?”

- 1. Please rate and comment on the importance of “A Theory of Effective Computer-Based Instruction for Adults.” Patterson (1986) defines importance as “a quality or aspect of having great worth or significance.” It should have some relevance to life and be applicable to more than a limited restricted situation.**
- 2. Please rate and comment on the preciseness and clarity of “A Theory of Effective Computer-Based Instruction for Adults.” Preciseness and clarity have to do with how clear and understandable the theory is. “A theory should be understandable, internally consistent, and free from ambiguities” (Patterson, 1986, p. xx). The easy of developing the hypotheses is another way of testing for clarity.**
- 3. Please rate and comment on the parsimony or simplicity of “A Theory of Effective Computer-Based Instruction for Adults.” Parsimony means that a theory contains a minimum of complexity, is economically constructed with a limited number of concepts, and contains few assumptions.**
- 4. Please rate and comment on the comprehensiveness of “A Theory of Effective Computer-Based Instruction for Adults.” A theory is comprehensive if it completely covers the area of interest and includes all known data in the field.**
- 5. Please rate and comment on the operationality of “A Theory of Effective Computer-Based Instruction for Adults.” A theory should be capable of being reduced to procedures for testing its propositions or predictions. Key concepts must be operationally defined with enough precise to be measurable. Patterson (1986) points out that not all concepts of a theory need to be operationalized; concepts may be used to indicate relationships and organization among concepts.**
- 6. Please rate and comment on the potential of the empirical validity that could be derived by converting the propositions developed for “A Theory of Effective Computer-Based Instruction for Adults” into empirical indicators. The empirical indicators are translated into hypotheses, which are confirmed or disconfirmed by empirical research.**
- 7. Please rate and comment on the fruitfulness of “A Theory of Effective Computer-Based Instruction for Adults.” The capacity of a theory to lead to predictions that can be tested and in turn leads to the development of new**

knowledge is referred to as its fruitfulness. The hypotheses or predictions are based on the theory's propositions. The propositions contribute to the fruitfulness of the theory and are tested through empirical research.

8. Please rate and comment on the practicality of "A Theory of Computer-Based Instruction for Adults." A theory is practical if it is useful to researchers and practitioners in organizing their thinking and practice by providing a conceptual framework for practice. A theory allows the practitioner to move beyond the empirical level of trial-and-error application of techniques to the rational application of principles.
9. Please comment on any other aspect of "A Theory of Computer-Based Instruction for Adults" that you wish to address.

The rating should be based on this scale.

Rating criteria (see attached Criteria for Evaluating Theory):						
		1 very low	2 low	3 moderate	4 high	5 very high
1	Importance/Significance					
2	Precision and Clarity					
3	Parsimony or Simplicity					
4	Comprehensiveness					
5	Operationality					
6	Empirical Validity					
7	Fruitfulness					
8	Practicality					

VITA

Janis Sue Lowe was born in Haynesville, Louisiana, and received her early education in the public schools in Claiborne Parish, Louisiana. She graduated from Haynesville High School in 1965. She was awarded a Bachelor of Science degree in business education from Northwestern State University in 1970 and a Master of Business Administration from University of Louisiana – Monroe in 1972.

She was employed as an accounting instructor at McNeese State University in Lake Charles from 1972-1973. She married and moved to New Orleans where she worked for New Orleans Public Service, Inc., from 1973-1977 as a tax accountant and a research analyst. In 1978 she moved to Baton Rouge and was employed by Gulf States Utilities Company from 1978-1992 as a customer service supervisor, rates and research analyst, and community developer. New Orleans Public Service, Inc. and Gulf States Utilities are companies of Entergy Corporation. In 1992 she was offered the opportunity to become a public servant as Assistant Secretary for the Louisiana Department of Economic Development where she served until 2001. In the 2001 she became a member of the staff of the Research and Statistics Division of the Louisiana Department of Louisiana where she is currently employed as a Labor Market Specialist Manager.

Her publications on high performance leadership competencies, andragogy, and computer-based instruction can be found in *Human Resource Development Review* (2000), *Academy of Human Resource Development Conference Proceedings 2002*, and *Journal of Research on Technology in Education* (2001-2002), respectively.