IN SEARCH OF A CONSTRUCTIVIST PARADIGM TO GUIDE THE PRACTICE OF ADULT INFORMATION TECHNOLOGY EDUCATION

by

Peter Wingping Hsu

M.A., George Washington University, 1997 B.S., University of the State of New York, 1994 B.A., Bob Jones University, 1975

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ABSTRACT

The purpose of this study was to develop and assess the suitability of a set of constructivist principles to guide practitioners of adult IT education and training. For the purpose of this study, constructivism was defined as an active learning process in which the learner develops meaning by continually interpreting and responding to his or her experiences. Consistent with this view of knowledge, learning must be situated in a real world context so that reality can be experienced by the learner, rather than explained by the teacher.

This qualitative study involved six distinct tasks: (1) review of literature to understand the basic arguments of pedagogical constructivism, (2) examination of dominant practices in adult IT education by analyzing two representative models in depth, (3) reflection on my own journey as a learner and IT professional to see how my own experience confirms or challenges constructivist theories, (4) synthesis of literature and experience into the Principles for Authentic IT Education, (5) assessment through a focus group process with 18 IT educators and professionals to gather their response to the constructivist approach, and (6) formulation of recommendations for IT program planning, curriculum development, and instructional development.

Three principles of authentic IT education were proposed. The first principle concerns authentic environment and context for IT education. It advocates using the environmental pressure inherent in the real world of IT practice to energize the learner's natural cognitive adaptation capability. This principle will lead educators to situate learning around real world work functions rather than bodies of IT knowledge. The second principle concerns authentic mediation. This principle posits that effective professional IT education is mediated by using

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real world tools, delivering useful and realistic products, and socializing in a community of practitioners. The third principle is authentic mission or purpose. This principle emphasizes the need to align IT educational goals with institutional missions and moral actions to change society.

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1 INTRODUCTION

The Doctor of Education in Leadership and Policy at UBC is a uniquely practicefocused program. It encourages students to continuously challenge their own educational practice using the intellectual resources of the program. At the same time, it also encourages students to challenge educational theory from the perspective of their own educational practice. This program is about improving one's own practice through critical reflection and introspection. This thesis, therefore, is a report of research into my own practice in <u>information technology</u> (IT) education in order to improve my own practice.

One aspect of the EdD program is a critical examination of the dominant <u>technical-rational</u> epistemological approach to education today. This approach is essentially grounded in behaviorism, objectivism, and positivism and is the pedagogical foundation of formal adult IT education (postsecondary, vocational, career, and professional continuing education). Various terms have been used to describe IT training based on this approach: performance based training, e-learning, outcome-based education, and so on. In recent years, another epistemological approach has begun to influence education and training in various academic, vocational and career fields. This theory of how we come to know is called constructivism. It holds that the learner through meaningful activities and social interaction constructs his/her knowledge.

This study presents a set of predominantly constructivist principles to guide practice in adult IT education. These principles evolved from a critical analysis of the literature in pedagogical constructivism and from critical reflection on current practice and on my own practice as an IT professional and a university teacher in Business and IT.

1.1 Background

Information Technology (IT) education and training is a large field in adult education practice today. International Data Group (IDG), the world's leading provider of technology market data, estimated the worldwide IT education and training market to be \$39 billion in the year 2006 (IDG, 2002). Despite its size, it is an area of adult education that is largely insulated from the influence of educational research. This insularity is not in the longterm interest of the IT industry or the people whose lives are affected by the rapid changes brought about by IT. Even though IT education has had 30 years to develop in colleges and universities, 75% of the employers surveyed by Computerworld in 2003 are still not satisfied with their college-educated employees (Hoffman, 2003). According to the survey, shortcomings are in the areas of business skills, troubleshooting skills, interpersonal communication, project management, and system integration. With the maturing of the IT industry and the growth of offshore outsourcing, IT positions are changing at a rapid rate. Against this backdrop, educators of IT professionals seem to have only one solution model to offer: performance-based training. The dominance of this technical-rational¹ model has reached into most professional development programs, university IT programs, and even high school computer science programs. While performance-based training has served the industry well since the 1950s, rapid technological changes brought about by the commercialization of the Internet have exposed the weaknesses of this educational model.

As an IT educator, I often use an alternative approach to the technical-rational model to guide my practice. This approach shares many of the learning methods of what I later came to know as constructivism²--learning by doing real work, learning in the context of the

workplace, learning from and with other learners, organizing learning around problems, and constructing my own meaning.

At the Information Technology Institute (ITI), a postgraduate computer institute, I successfully implemented a professional education program based on these principles. ITI started as a trade school in Halifax providing a full time diploma program in IT. In 1996, I was privileged to be the first Director of Instructional Design and Curriculum Development at ITI. In that year ITI ceased to use a performance-based approach to IT learning where students were taught how to perform various computer programming functions in a step by step, topic by topic manner. Instead, we launched a totally different curriculum based on doing real life IT projects that integrated various topics and functional skills like programming, design, teamwork, communication, and so on. We changed classrooms into "team rooms," replaced lectures with "team time," and brought in a way of learning that emulates the work world. At first the students were frustrated; they were looking for the old familiar lecture, lab, and exam. The teachers were exasperated; they wanted "to teach." But the employers were ecstatic. They came on campus in droves to snap up these "experienced entry-level" IT professionals. Enrollment in the little school grew 500% in four years. It was the first school to IPO on the Toronto Stock Exchange. At the height of the "Tech Bubble," ITI was sending over a thousand professionals each year to IT companies alone - more than all the Canadian university Computer Science programs put together.

My experience with this alternative form of IT education provided me with something to share with other adult educators. Yet, at the same time, it left me with unanswered questions. I needed to have a deeper understanding of how constructivism works and how these methods can be transferred to other IT educational contexts such as universities. As

early as 1993, Wilson foresaw a future for adult education where context, culture, and tools would play an important role. Like Hansman (2001), I believe that adult IT educators need to consider providing learners with real-world, context-based learning.

Finally, this thesis is also a search for that "something more" in IT education. Even though I was satisfied with the knowledge and skills outcome of the ITI experience, I am dissatisfied with other educational aspects of this approach. As a Christian educator, I find that I am not fulfilling my vocation as a teacher by just equipping students to function as effective professionals in a highly technological world. I desire to practice the kind of IT education that is consistent with my worldview--one where the moral and ethical dimensions are not separated from the technical and professional ones.

1.2 Statement of the Problem

The review of current practices in IT education demonstrated that behaviorist instructional models dominate adult IT education and training, even though the literature review pointed to the potential of a constructivist model. There is a need to investigate how to integrate constructivism into current practice of adult IT education. The UMI dissertation database showed many studies have been published on the application of constructivist principles to various educational domains, such as math, social sciences, language, and teacher's education. However, few are related to IT education. There is a need to continue the inquiries started by other IT practitioner-scholars like Luterbach (1997), who compared constructivist instructional design strategies for teaching computer mastery; Bartfeld (1999), who developed a model of effective training for end-user computing; and Ulmer (1999), who studied the effectiveness of using constructivism to learn computer software. As I concluded in the literature review, while these studies are informative in the application of

constructivism to one form or another of IT learning, not one study concerns the application of constructivism to the development of the IT professional. To one extent or another, the findings of Luterbach, Bartfed, and Ulmer still focus on how a learner could best acquire IT knowledge structures through the use of constructivist learning methods such as problem-based learning. However, a review of the literature of Vygotsky (1978), Freire (1997), Lave and Wenger (1990) has unlocked more potential applications from the social and critical perspectives of constructivism.

On a more personal level, I saw this study as a major step towards understanding my practice. In order to improve my own practice and help others to improve theirs, the experience of what works or doesn't work must be connected to theories. According to Brookfield (1995), theories can better help us explain our failures and successes. These ideas combined with many years of practice have helped me to derive a set of educational principles that may benefit other practitioners.

1.3 Purpose of the Study

The purpose of this study is to develop and evaluate a set of principles to guide practitioners of adult IT education and training, especially for university-based IT educators. This study was guided by the following research questions: (a) How can pedagogical constructivism inform current practice of adult IT education, especially in the university context? (b) How can pedagogical constructivism explain my experience as a learner and IT educator? (c) What principles could be distilled from the pedagogical constructivism literature and my own experience to guide adult IT education? (d) How will university IT educators respond to a constructivist approach to IT education?

1.4 Study Tasks

The methodology employed in this study can be viewed as eclectic since it did not follow a mode of inquiry traditionally used by educational researchers. Nonetheless, the approach used is perhaps most effective for achieving the pragmatic purpose of "studying practice to improve practice." The nature of the EdD program affected the way this study was designed, i.e., learning through <u>reflection on practice</u> in an <u>authentic</u> context. The EdD website (<u>http://www.edst.educ.ubc.ca/programs/Ed-D/instruction.html</u>) states the following:

The purpose of the program is to engage students in the advanced study of educational leadership and policy in order that they can both critique and improve their own practice. It is this focus on practice – studying practice, trying to understand practice, being constructively critical of practice, improving one's practice- that primarily distinguishes the program from more traditional doctoral programs... ...students can be thoughtful about practice and introspective about their own practice, and the jobs that students hold can furnish ample material about "real" practice for this thoughtfulness and introspection to occur, and to occur, moreover, with high relevance to the participants' own jobs and careers...

Therefore, the type of research consistent with the purpose of the EdD program should be critically reflective of my own practice as well as situated in the context of that practice. Furthermore, the EdD thesis should be <u>authentic</u> in the sense that it should be a useful product to the researcher in his or her present practice. The following sections explain in detail how each task was carried out.

This study began with an assumption derived from practice: that constructivist educational theories have potential to significantly impact the current practice of IT education. It aimed to formulate principles to guide the practice of adult IT education. This study involved six distinct tasks. Although these tasks are more or less sequential, they are also iterative and spread over a period of eight years (1998-2006). During this period, my work as an IT and business professor constantly brought me back to reflect on my twenty years of experience as an IT professional, on the EdD classes between 1998 and 2000, on the literatures reviewed in 2001 to 2002, on the principles of authentic IT education I first conceptualized in 2003, and on the comments from the focus groups in 2004. The following section is an overview of each task with a more detailed discussion of Task Five-the focus group methodology.

1.4.1 Task One--Literature Review

I reviewed literature of pedagogical constructivism to understand its basic arguments and to find research opportunities in IT education. After identifying the plurality of constructivist scholarship, I used four criteria to select literature for review: (a) since this study was primarily about teaching and learning, I selected literature on pedagogical constructivism for review; (b) as adult IT education is practiced in both academic and organizational settings, I broadened my literature search from the usual domains of education and psychology into the realms of business management and human resources development; (c) I tried to understand basic arguments for constructivism from the seminal works of Piaget, Vygotsky, Dewey, and Freire; (d) To avoid "reinventing the wheel" and to discover opportunities for research, I examined three doctoral dissertations on the application of constructivist theories to some aspects of IT education.

1.4.2 Task Two--Dominant Practices Review

After reviewing the literature of constructivism, I used three steps to examine the dominant practices in adult IT education today in order to understand how constructivism challenges current practice: (1) I examined the defining standards for academic educational practice as embodied in the Association for Computing Machinery (ACM) 2002 Model Curriculum for university-based IT programs; (2) I examined corporate IT learning practice through an analysis of the IBM 4-Tier Blended Learning Model; (3) I explored the potential applications of constructivism to adult IT educational practice.

1.4.3 Task Three--Autobiographical Reflection

In his book <u>Becoming a Critically Reflective Teacher</u>, Stephen Brookfield (1995) asserts the value of autobiography as a vehicle to self-understanding. Autobiographical reflections have been used in ethnographic research and are encouraged by feminist and postmodernist researchers. Mezirow's transformative learning theory (1991) also supports the view that perspective transformation

begins when we encounter experiences, often in an emotionally charged situation, that fail to fit our expectations and consequently lack meaning for us, or we encounter an anomaly that cannot be given coherence either by learning within existing schemes or by learning new schemes. (p. 94)

I believe that my own educational philosophy, to a large extent, is the outcome of testing educational theories against various experiences in my practice and reflecting on these from the perspective of my worldview. Therefore, examining these autobiographical events is consistent with the kind of critical reflection practiced in the EdD program as well as instrumental in developing a framework for constructivist practice.

To this task, I brought personal experience to bear on the study of theory and practice. I considered how my own experience as a learner and IT professional and the reading of theory could coalesce into a set of principles to guide adult IT education. I performed this task in three sub-tasks: (1) to unveil personal biases and inherent assumptions, I tried to situate "me as a teacher" within Pratt's Five Teaching Perspectives (1998); (b) I traced some of the significant events that have formed my dominant and recessive teaching perspectives; (c) I reflected on constructivist literature reviewed earlier to see how my own experience confirms or challenges constructivist theories.

1.4.4 Task Four--Principles Development

I synthesized literature, experience, and dominant IT educational practices into a set of constructivist principles to guide adult IT education. The complicated ideas of constructivism and all other theories were packed into the word <u>authenticity</u> and reduced to four simple principles for ease of communication. They are the principles of authentic environment, context, mediation, and mission. I first published these principles as part of a handbook used to guide my educational consulting practice. After a period of usage, these principles are then written into chapter 5 of the thesis.

1.4.5 Task Five--Focus Groups

After I synthesized the pedagogical constructivist theories into principles for adult IT education, I conducted three focus groups with college IT educators to gather their response to such an approach. Chapter 6 reports on the findings. Since this was the most complicated of the six tasks and involved external institutions and educators, I elaborate on each step within this task in the beginning section of chapter 6.

1.4.6 Task Six--Reflection on Implications and Conclusion

After collecting and analyzing the information gathered from the focus groups, I brought closure to the study in chapter 7 by (a) revisiting the research questions that prompted this study and drew conclusions to each individual research question, (b) discussed the relevance of this study to IT education in 2007, and (c) raised new practice recommendations to three specific groups of practitioners--academic IT leaders in program planning, curriculum development, and instructional development; corporate IT educators and trainers; and education researchers.

2 LITERATURE REVIEW

Two purposes drove the literature review in this study: understanding the basic arguments and pedagogical implications of constructivism and locating gaps or opportunities for research or the application of constructivism to adult IT education. But first, what is constructivism? There is no simple answer to this very basic question. Because constructivism is both a philosophy of knowledge as well as an approach to knowing, the answer depends greatly on the academic discipline from which one comes. Riegler (2005) identified at least seven disciplinary approaches to constructivism: the biologicalphysiological approach, the cognitive-psychological approach, the educational approach, the engineering-computer scientific approach, the historical approach, the philosophicalepistemological approach, and the physical approach.

While different disciplines see constructivism from different perspectives, they express some common themes. First of all, constructivists question the notion of objectivity in knowledge. They see the observer as an inseparable part of scientific knowledge, and constructivist approaches emphasize an active human agency in the process of knowledge construction. Secondly, constructivists maintain an agnostic view of reality; they are neither realist nor idealist. They simply reject the notion that reality could be represented by ideas. Knowledge could only mean the reconstruction of prior operations. If the reconstruction matches prior conclusions, then it is true; otherwise it is false (von Glasersfeld, 2005). Thus, knowledge of reality is not something passively received but actively brought forth by the subject. Finally, constructivist approaches emphasize more flexibility and less dogma. The focus of their research "moves from the world that consists of matter to the world that consists of what matters" (Riegler, 2005).

Since knowing means the active construction and reconstruction of knowledge by a subject, the identity of the subject depends greatly on what problem the researcher is addressing. To the biologist-physiologist, the subject could mean a living cell or an organ. To the cognitive psychologist or teacher, the subject could mean a child or any individual learner. To the engineer, the subject could mean a computer system or a network of machines and human beings. To the social constructivist, the subject could mean a community, a school, a team, and so on. Since IT education traverses individuals, communities, and systems, the selection of literature for review had to be guided by the purpose and scope of the study to avoid being sidetracked.

First, most literature on philosophical constructivism was excluded. Philosophical constructivism is an attempt to answer questions of knowing: how does one come to know something? Can one know apart from experience? Is knowledge something waiting to be discovered, or is all knowledge only perceptions, as stated by Socrates? Trying to answer these questions would inevitably take us from epistemology into ontology and metaphysics, which is beyond the scope of this study. As teachers and not philosophers, we recognize different ways of knowing and learning, of which constructivism is one way. Therefore, this study is concerned with pedagogical constructivism or the application of constructivist concepts in teaching and learning. For the purpose of this study, I visualized an epistemological (rather than ontological) continuum with objectivism on one end and radical constructivism on the other. It is on this continuum that educational and instructional theorists anchor their theories, locate their practices, and conduct their debates. In my opinion, the underlying dimension of this continuum is the degree of objectivity or subjectivity of knowledge. As one moves along this continuum, one's view of knowledge

moves from greater objectivity to greater subjectivity. On the objectivist side of the continuum, one can find theorists like Merrill, Drake, Lacy, and Pratt (1996) who claimed "that instruction is a science and that instructional design is a technology founded in this science" (p. 5). This claim is based on the assumption that all knowledge is external, waiting to be discovered or transmitted. Much of IT education and training is built on this view. On the other end of the continuum is radical constructivism, which assumes that all knowledge is constructed by personal experience and is essentially subjective (von Glaserfeld, 1995). Pedagogical constructivism, however, does not operate at the radical end of this epistemological continuum. Rather, theories of a less radical nature, such as social constructivism, form the foundation for constructivist learning methods like collaborative learning or experiential learning.

Secondly, the review began with foundational constructivist literature and progressively narrowed towards literature more relevant to adult IT education that can be segmented into four categories:

 Foundational literature. I reviewed the seminal works on constructivism by Piaget (1968), Vygotsky (1978), and Dewey (1916). Their works in general and Vygotsky's work on social constructivism in particular formed the basis of the next level of literature. I have included the works of Paulo Freire in this group of literature although Freire is not generally considered a constructivist in educational scholarship. However, his pedagogy carries a strong emphasis on continuous active agency and self-development, common themes of constructivism. Unlike Piaget, Vygotsky, or Dewey, Freire's critical pedagogy

takes into account the power relationship in learning and is a useful tool to analyze dominant IT educational practices.

- 2. Situated learning literature. From the more general works on cognitive and social constructivism, I narrowed my review to literature on situated learning--a contemporary elaboration of the basic constructivist arguments of Dewey, Vygotsky, and Piaget. Furthermore, situated learning has developed pedagogical approaches, such as cognitive apprenticeship and community of practice (CoP) that recognize professional education as a complex social activity.
- 3. Constructivism in IT education research literature. I examined three doctoral dissertations that included constructivism and some aspects of IT education and training. These studies were useful in identifying gaps in research in the application of constructivism to IT education.
- 4. Critiques of constructivism. I examined various arguments against pedagogical constructivism.

2.1 Foundational Literature

Like other teacher-researchers whose dissertations on pedagogical constructivism I examined (Miller, 2000; Luterbach, 1997; Branigan, 2000), I began by reviewing the works of Piaget, Vygotsky, and Dewey. I found that employing and interpreting Piagetian, Vygotskian, Deweian, and Freirean theories was helpful to this study because each provides perspectives of learning that are different from the current performance perspective in adult IT education. In addition to the pervasive psychological arguments, these writers added biological, philosophical, and political perspectives to learning.

2.2 Piaget's Cognitive Constructivism--An Argument from Biology

Jean Piaget (1896-1980) is credited most widely as a developer of early constructivist theories in his work on <u>genetic epistemology</u>. Piaget approached human knowledge from a historical and biological viewpoint. Yet his style of writing is long on explanation and short on examples. I can interpret Piaget's theory in two ways: (a) human knowledge has a genetic nature and (b) human beings are learners genetically.

2.2.1 Genetic Nature of Human Knowledge

According to Piaget (1968), human knowledge is active in nature, perpetually evolving from a less adequate (for survival in an environment) to a more adequate level. In his own words,

To know is to assimilate reality into systems of transformations.... By virtue of this point of view, I find myself opposed to the view of knowledge as a copy, a passive copy, of reality...To my way of thinking, knowing an object does not mean copying it – it means acting upon it. It means constructing systems of transformations that can be carried out on or with this object. Knowing reality means constructing systems of transformations that correspond, more or less adequately, to reality. They are more or less isomorphic to transformations of reality. The transformational structures of which knowledge consists are not copies of the transformation in reality; they are simply possible isomorphic models among which experience can enable us to choose. Knowledge, then, is a system of transformations that become progressively adequate. (Lecture 1)

In plain language, Piaget was saying that human beings come to know about an object by doing something with that object, rather than copying that object. For example, to get to know an apple (versus just <u>knowing about</u> an apple) is to eat an apple, to bake a pie with apples, to bait a raccoon with an apple, and so on. The acts of eating, baking, and baiting are "systems of transformation." However, because human beings are all different in their needs to adapt to the environment, we assimilate reality differently, or we construct knowledge differently. Even systems of transformation (e.g., baking an apple pie) that might look the same are really "genetically" different (isomorphic) because they evolved through different historical processes, e.g., learnt and modified from different cooking classes, mothers, recipes, trial and error, and so on. In this view, the effects of learning are not always predictable, and reality often appears as a product of discontinuities (Torres, 1999).

2.2.2 Human Beings Are Learners Genetically

As a teenager, Piaget studied mollusks (snails) by transplanting them from lakes to running water and vice versa. He observed the different shapes of the shells the mollusks developed as an adaptation to the dynamics of the environment. If the mollusk sits in still water, it will create one kind of shell. If the mollusk sits in a running river, it will create a smoother, flatter shell to minimize resistance. In another words, an organism must <u>fit</u> within the constraints of its environment (von Glasersfeld, 1997).

According to Piaget, human knowledge construction is somewhat similar to the shell construction of the mollusks. First of all, we are learners by design. Knowledge construction is in our genes, just like shell construction is in the genes of the mollusks. We have to learn to survive and not be washed away by environmental threats. Secondly, humans construct knowledge (operative cognitive structures or theories) by interacting with the <u>environment</u>.

The process of change involves <u>assimilation</u>, <u>accommodation</u>, and <u>equilibration</u>. Piaget (1955) explained:

Assimilation and accommodation are therefore the two poles of an interaction between the organism and the environment, which is the condition for all biological and intellectual operation, and such an interaction presupposes from the point of departure an equilibrium between the two tendencies of opposite poles.... Every acquisition of accommodation becomes material for assimilation, but assimilation always resists new accommodations. (¶1)

Assimilation is applying knowledge one currently has to a new situation or, as Piaget (1955) put it, "to subordinate the environment to the organism as it is" (¶1). For example, my Uncle Ted is an amateur stock trader. He reads the Wall Street Journal every morning for news, and whenever he wants to trade, he instructs his broker by telephone. Until the last few years, this process had worked well for him. Then came the Internet. The environment changed quickly before his eyes. The information from the WSJ always came a little too late for any meaningful trade. His broker's commission seemed to go higher and higher, eating away any gain he could earn. Being techno-phobic, he tried to assimilate to the new technological environment any way he could, as long as he did not have to use a computer. In fact, he invented many reasons why an amateur trader should not use the computer. He tried to get up earlier in the morning to catch the Bloomberg news. He even tried to use the cell phone to instruct his broker. The fact is assimilation does not always work. Uncle Ted started to experience perturbations. Gradually, he began to change his theory about successful trading to include using the Internet and the computer. He is accommodating. According to Piaget (1955), accommodation is when the organism bends to the successive constraints of

the environment. First, my Uncle Ted learned to surf the web for breaking news instead of waiting for the morning paper. His timing improved almost overnight. However, his commission expenses were still high, and many times, he wanted to make a trade but could not reach his broker. So he signed up with Ameritrade, an online discount brokerage. He started by making small trades online until he became confident with the new process. He is now doing 100% of his trades online and happy as a lark, until the next storm comes. Then the process of <u>equilibration</u>, or achieving a balance between <u>assimilation</u> and <u>accommodation</u>, will start all over again (Campbell, 1997).

2.2.3 Significance of Piaget's Cognitive Constructivism

So how is Piaget's theory of cognitive constructivism significant to this study? I believe that Piaget's ideas can stimulate the practitioner to new ways of viewing knowledge, the educational environment, the learner, and the instructional process.

For example, let us look at the significance of context and environment for IT education. Most adults live under a constant threat to their state of equilibrium from technology-induced changes. Large numbers of jobs are displaced or substantially changed by the introduction of information technologies. Even if a person is not in the labor market, his or her life is constantly bombarded by wave after wave of technological changes--the ATM, DVD, e-mail, the Internet, cell phones, broadband, digital cameras, and the iPod, just to name a few. In Piaget's theory of cognition, the first level of adaptation is on the practical level of survival. An organism has to devise schemes of action to circumvent the obstacles and perturbations the environment places in its path (von Glaserfeld, 1997). Whether the destination of that path is getting and keeping a better job or getting money out of the bank to do grocery shopping or simply trying to send a grandchild's picture to a distant grandmother,

technology stands in the way. If Piaget is correct, then there is already a huge environmental pressure for practically every mind to become <u>fit</u> in order to <u>survive</u>. Teaching or instructional design will need to make full use of this favorable environment for learning. In fact, the magnitude of this environmental advantage cannot be fully appreciated until one compares it against the relevancy of subjects like history, literature, mathematics, and languages.

Secondly, let us consider how Piaget's ideas affect the way we look at adult IT learners. Just as shell-construction is a genetically determined function of the mollusk, the theory of genetic epistemology assumes that learning is a genetically determined function of the human mind. The mind is always active. It is never a passive vessel waiting to be filled. Not only are "educated" minds active, but all human minds are also actively constructing knowledge structures necessary for survival. We see sports fans digesting volumes of data on games, races, and players and making meaning out of those data. They could be doing that to survive the boredom of daily life, survive as gamblers betting on games, or just gain pleasure out of being a sports fan.

American philosopher Alfred North Whitehead's (1929) educational ideas echoed Piaget's viewpoint. In his often quoted essay, <u>Aims of Education</u>, Whitehead argued that education does not require that the mind first be sharpened with skills, facts, or formulae before it can be used. Rather, the relevance of those skills, facts, and formulae should be immediately relevant from the outset. In other words, Whitehead is saying that most learners are ready to learn. It is up to the instructor to bring out the relevance of the subject matter so the learner can connect to it and perform the genetic function of equilibration. This kind of

thinking challenges performance-based instructional design methods used in IT education and training today where the function is often removed from a meaningful context.

Cognitive constructivism also encourages learner ownership of the process and product of learning. Unlike in traditional scientific research where the investigator works from the outside trying to be objective, the constructivist tries to think in a way that includes the observer:

No longer do we have to think of ourselves as powerless, passive receivers, who are not only physically but also mentally determined by the structures of a pre-established universe. Instead, we become aware that our thoughts and actions are ours, and that it is we who have generated them and therefore have to assume responsibility for what we think and do. (von Glaserfeld, 1997, p. 4)

2.3 Vygotsky's Social Constructivism--An Argument from Psychology

If Piaget is the "father" of modern constructivism, then Vygotsky must be its "mother." The collective ideas of these two gave birth to a host of learning theories that emphasize the active construction of knowledge in a collaborative learning environment. The principal difference between Piaget and Vygotsky lies in the importance they place on the mediation of other people as well as tools and symbols (artifacts) in the learning process (Cole & Wertsch, 1996). Vygotsky (1978) called this "cultural mediation." Like Piaget, he studied human intelligence development by examining the intellectual development of children. Vygotsky found that

The most significant moment in the course of intellectual development, which gives birth to the purely human forms of practical and abstract intelligence, occurs when speech and practical activity, two previously completely independent lines of development (in a child), converge. (p. 24)

In the course of solving problems, higher psychological processes are developed:

Children confronted with a problem that is too complicated for them exhibit a complex variety of responses including direct attempts at attaining the goal, the use of tools, speech directed toward the person conducting the experiment or speech that simply accompanies the action, and direct verbal appeals to the object of attention itself. (p. 30)

So when my Uncle Ted was busy "<u>assimilating</u> and <u>accommodating</u>" his way to becoming an online stock trader, he had a lot of "outside help." He bought books to read, joined an investment club to learn from more seasoned traders, called the Ameritrade hotline often for help, and acquired the language of computer users and online traders. In other words, he directed his intellectual tools to solve his immediate problem and became smarter in the process.

2.3.1 Mediation of Tools and Symbols

According to Vygotsky (1978), the human mind consists of more than just the grey matter between our ears; it is extended into and intertwined with all the artifacts that we use and make. <u>Artifact</u> is used as a broader term to include language various systems for counting, mnemonic techniques, algebraic symbol systems, works of art, writing, schemes, diagrams, maps, drawings, and so on. In today's technological environment, we could include all kinds of media, the Internet, toys, computers, software, and hardware. To

understand how the biological mind is fully intertwined with gadgets or artifacts, I need to look no further than what I am doing here. I am building a set of educational principles, a <u>pedagogical tool</u>, upon which other teachers will build other pedagogical artifacts like courseware and curriculum. I used Google, a <u>technological tool</u>, to find reference books and journals, which are <u>historical-cultural artifacts</u>. I shared these principles with a broader community of educators through the mediation of the English language as well as the language of education, a <u>cultural-symbolic tool</u>. Sometimes, it is not only problems that can stimulate intellectual development: Vygotsky found that artifacts themselves could inspire mental processes that require acting upon the artifacts. He found that "things dictate to the child what he must do: a door demands to be opened and closed, a staircase to be climbed, a bell to be rung. In short, things have such an inherent motivating force…" (Vygotsky, 1978, p. 96). However, effective learning requires not only the mediation of things but also of other people.

2.3.2 Mediation of Other People

Vygotsky's most important legacy to education is perhaps his hypothesis on the "zone of proximal development" (ZPD) (Wells, 1999). According to Vygotsky (1978), "the most essential feature of our hypothesis is the notion that developmental process lags behind the learning process, this sequence then results in zones of proximal development" (p. 90). There are vastly different interpretations of the ZPD (Lave & Wenger, 1991). However, based on the "scaffolding" interpretation, we know from experience that the learner can perform some things on his or her own (without assistance). On the other hand, the learner cannot do other things, even with assistance. But in between these two zones are a number of things the learner can do with assistance from another person. This in-between zone is the ZPD. How

transformation occurs in the ZPD is of utmost interest to educators since schools and teachers mostly operate in this zone. In fact, Vygotsky (1978) considered, "What a child can do with the assistance of others might be, in some sense, even more indicative of their mental development than what they can do alone" (p. 85).

Much has been written about the ZPD; however, one particular characteristic is of special interest to this study. Learning in the ZPD "does not require that there be a designated teacher; whenever people collaborate in an activity, each can assist the others, and each can learn from the contributions of the others" (Wells, 1999, ¶4). Thus, Vygotsky has laid the theoretical foundation for collaborative learning.

2.3.3 Significance of Vygotsky's Social Constructivism

How does Vygotsky's constructivism affect the way we look at teaching and learning? First, Vygotsky is saying that there is a place for teaching. But teaching, in order to be effective, has to be mediated by a rich environment of artifacts and people. For example, in the teaching of writing in his day, Vygotsky (1978) found that "the most vivid example of the basic contradiction that appears in teaching... that writing is taught as a motor skill and not as a complex cultural activity.... writing must be relevant to life" (p. 118).

That leads us to ask the crucial question: How can we look at professional IT education as a <u>complex cultural activity</u>? Asking this kind of question leads us to seek out instructional paradigms that include a variety of people and exploit a range of useful artifacts or learning media. It is not just a matter of bringing in all kinds of artifacts, but we shall seek a framework where these artifacts can transform mental functions in a fundamental way (Cole & Wertsch, 2002). We shall naturally pay more attention to learning that is situated in the context of practice rather than in an academic context. The kind of outcome we shall look

for will be <u>artifacts</u> reflecting students' understanding as well as the demand of real world IT. In terms of assessment methods, we shall look for instruments that will not only assess <u>intermental</u> or <u>socialized</u> learning but also <u>intramental</u> or <u>internalized</u> learning.

2.4 Dewey's Progressive Education--An Argument from Philosophy

While Piaget and Vygotsky have said much about learning, they did not say much about education. John Dewey was a philosopher who lived between 1859 and 1952. The rejection of <u>dualism</u> is central in the writing of Dewey. Dualism is a philosophy that separates the soul and the body, the spiritual and the physical, inner and outer, character from conduct, ends from means, and motive from action (Dewey, 1916). Furthermore, he rejected the separation of school learning from real life work and emphasized the importance of <u>morals</u> and <u>experience</u> in education. He lived in a time when many families were moving from farms into cities. Dewey observed the kind of education children received in the city was far less <u>holistic</u>, thus more <u>dualistic</u>, than the education the children received on the farm. On the farm, children learned by doing useful work alongside their parents, using real tools and real material. Moreover, the entire process of farming was observable to the child. Schools in the city, on the other hand, shut off children's chances to participate naturally in the adult world of work. Therefore, students were isolated from reality. The methods were passive with the teacher with the textbook being the primary means to learning.

Dewey founded the University of Chicago Laboratory School based on three curricular principles. First, development of the student's mind is the end, and subject matter is only the means. Secondly, learning must be integrated and project-oriented, not divided into small units. Finally, the progression of the curriculum must be from practical experiences (such as planting a garden) to formal subjects (such as botany) to integrated

studies (such as the place of botany in the natural sciences) (Berryman & Bailey, 1992, p. 29). Today we identify these principles with constructivist methods of teaching.

Dewey also opposed the separation of morals from the quest of knowledge in education. "Moral education in school is practically hopeless" (Dewey, 1916, ¶ 3) unless it is integrated into and reinforced by the whole regime of the curriculum. He maintained that a vital connection between occupational knowledge and moral action is important in education.

Finally, Dewey believed that schools must be an authentic microcosm of community life. Schools should be places where the common experience is socially negotiated, involving intercourse, communication, and cooperation. Learning in school should be highly connected to what is going on in the community. Schools should have numerous points of contact with the larger social interests of the community. In this way, social concern and understanding would be developed (Dewey, 1916).

How does Dewey's constructivism affect the way we look at teaching and learning? First, I believe that it will cause us to critically examine <u>dualism</u> in our pedagogy. We need to be aware of separations between theory and practice, knowing and doing, technical and moral, and so on. We need to ask questions of <u>integrity</u>--the "<u>integrated-ness</u>" of school and society, of duty and self-interest, of curriculum with context, and so on. Since adult IT education is something one learns to do, are existing curricula organized from an occupational standpoint, or are they purely subject knowledge? In terms of outcome, we should look for the students' ability to transfer smoothly from school-to-work, their ability to reflect on their practice both morally and technically, and their ability to provide leadership in a community of practitioners.

2.5 Freire--An Argument from Politics

Politics is about the arrangement of power and interest, and the nature of education is highly political. Paulo Freire (1921-1997) wrote the classic book <u>Pedagogy of the Oppressed</u>, in which he advocated a form of constructivism born out of political struggle for freedom and equity.

Freire (1997) first examined the pedagogy of the "oppressor" in education; he called this practice "banking" education. In this authoritarian model, the role of the teacher is to deposit, or bank, subject knowledge in the mind of the student, as if it was an empty vessel to be filled with information. In this oppressive model, the teacher is the subject of learning. The oppressed wants to model the oppressor, to follow the oppressor's prescription, and fears freedom (Freire, 1997). This oppressive model, said Freire, mirrors the attitudes and practices of an oppressive society in which to be is merely to have (Schugurensky, 2002).

Freire proposed a "liberatory" or "emancipatory" educational model. Key characteristics of liberatory pedagogy are

based on a horizontal relation between teachers and learners (co-intentionality), on critical thinking and on social transformation. In Freire's model, the teacher becomes a facilitator, the traditional class becomes a cultural circle, the emphasis shifts from lecture to problem-posing strategies, and the content, previously removed from the learners' experience, becomes relevant to the group. (Schugurensky, 2002, p. 4)

Freire (1997) saw "that a revolution is achieved with neither verbalism nor activism, but rather with <u>praxis</u>, that is <u>reflection</u> and <u>action</u> directed at structures to be transformed" (p. 107). Piaget (1972) titled one of his books <u>To Understand is to Invent</u>. Liberatory pedagogy supported this notion of continuous <u>re-inventing</u> of human society as an essential

human function, at least for those who understand systems of domination. Like Piaget, Freire believed learning must be immediately relevant but from a socio-political point of view. He also shared Vygotsky's notion of <u>cultural mediation</u>. Human mediation is especially important in liberatory education. According to Freire, "Here, no one teaches another, nor is anyone self-taught. People teach each other, mediated by the world, by the cognizable objects which in banking education are 'owned' by the teacher" (p. 61).

So how is Paulo Freire's constructivist pedagogy relevant to education today? Liberatory education urges us to examine the power relationships within the learning community and with society at large. Freire posited a horizontal relationship between the teacher and the learner. This kind of relationship is fundamental to the success of learning communities, as we shall see in the next section. Furthermore, information technology is not supposed to be an end in itself. It is supposed to bring a better quality of life to humankind. However, simple facts and observations tell us that such is not the case. The knowledge economy has brought unprecedented economic polarization within and between nations. Even in the rich countries where technological toys are stacked to the rafters in homes, time, compassion, and happiness are scarce. In this reality, IT education has to ask the question, "For what?" In order for IT education to be more than just learning to earn or to create one more whiz-bang gadget, a pedagogical framework for today must have more to offer. IT education will not be complete without posing problems brought about by technology. This approach should nurture more critically reflective professionals who are more than just competent technologists but are change agents who can make a positive impact on the quality of life globally.

2.6 Summary of Meta-theories and Implications for IT Education

In this section, I dug into some well-mined theories for the basic arguments and implications of constructivism, and I was not disappointed. Piaget reminded me that all human beings, because they have to survive, are ready and able to learn by design. If educators could just harness the disruptive power of technological change, the learner's natural instinct would provide much of the impetus for learning. Furthermore, effective learning in the ZPD must be mediated by a rich environment of artifacts and people, according to Vygotsky. Dewey provided important insights into how curriculum should be organized around occupations rather than subjects and move from practical experience to formal knowledge. Finally, Freire challenged educators to ask the question, "For what?" Should there be more to IT education than better social efficiency and innovative hedonism or nihilism? Coming from four very different countries--France, Russia, America, and Brazil--these theorists, nevertheless, came to a common conclusion that authentic human experience is the best teacher. Their collective arguments and ideas provide the necessary theoretical foundation to support the principles presented in this thesis.

While the arguments reviewed so far, mostly advanced in the early part of the last century, provided the theoretical basis for pedagogical constructivism, it is not clear how these ideas could be implemented in contemporary society, particularly in the context of professional and vocational education. From there, the search led me to contemporary literature on situated learning that elaborated on the foundational theories of constructivism, particularly social constructivism.
2.7 Situated Learning Literature

I approached situated learning literature on two different levels. First, I examined the genetics and principles of the theory. Then, I studied two pedagogical models built upon situated learning theory: Cognitive Apprenticeship and Community of Practice (CoP). Finally, I reflected on the implications of situated learning for IT education.

2.7.1 The Principles of Situated Learning

The seminal work for situated learning was done in the late 1980's and early 1990's. In her studies of Vai and Gola apprentice tailors, Jean Lave (1988) found that tailors learned through a combination of observation, coaching, and practice. In 1989, Brown, Collins, and Duguid published "Situation Cognition and the Culture of Learning" in which they posited that situations are integral to cognition and learning. In 1990, Collins, Brown, and Newman first advanced a pedagogical model based on situated cognition: the Cognitive Apprenticeship model. According to Lave and Wenger (1991) considerable confusion existed at that time over the meaning of situated learning:

On some occasions "situated" seemed to mean merely that some of people's thoughts and actions were located in space and time. On other occasions, it seemed to mean that thought and action were social only in the narrow sense that they involved other people, or that they were immediately dependent for meaning on the social setting that occasioned them. (p. 32-33)

In 1991, Lave and Wenger published <u>Situated Learning – Legitimate Peripheral</u> <u>Participation</u>. This book gives a clearer explanation of what Lave meant by situated learning. It is explained as a form of Legitimate Peripheral Participation (LPP). This book has been reprinted every year since first published in 1991. Today, situated learning, also referred to as

situated cognition, research is located in the field of cognitive science. This interdisciplinary field encompasses psychology, linguistics, anthropology, computer science, philosophy, and neuroscience (Berryman & Bailey, 1992). It is interesting to note that both Brown and Wenger came from an IT background, with earned doctorates in computer science. Wenger, a student of Brown and Lave, then went on to develop a learning model called Community of Practice (CoP).

2.8 Principle Arguments of Situated Learning

Situated learning is primarily an elaboration of Vygotsky's theoretical work. Social constructivism posits that effective learning is mediated by a rich combination of tools and people. But what kind of tools and people should mediate learning, and how does the process work?

First of all Brown, Collins, and Duguid (1989) provided a lucid elaboration on the idea of tools in learning. While Vygotsky (1978) considered language a perceptive tool for a child to learn about the world, Brown, Collins, and Duguid (1989) thought of all conceptual knowledge as tools and not abstract, self-contained entities:

People who use tools actively rather than just acquire them, by contrast, build an increasingly rich implicit understanding of the world in which they use the tools and of the tools themselves. The understanding, both of the world and of the tool, continually changes as a result of their interaction. Learning and acting are interestingly indistinct. Learning becomes a continuous, life-long process resulting from acting in situations...Because tools and the way they are used reflect the particular insights of communities, it is not possible to use a tool appropriately without understanding the community or culture in which it is used. (p. 32)

Thus, Brown (1989) concluded that "to learn to use tools as practitioners use them, a student, like an apprentice, must enter that community and its culture" (p. 3).

On the other hand, Lave and Wenger (1991) "located learning squarely in the processes of coparticipation, not in the head of individuals... Rather than asking what kinds of cognitive processes and conceptual structures are involved, they ask what kind of social engagements provide the proper context for learning to take place" (p.13-14). In other words, learning is not some activity that lead to practice. LPP sees learning as an integral and inseparable part of practice.

Situated learning as LPP is not a pedagogy; rather, it is a "conceptual bridge linking the common processes inherent in the production of changing persons and changing communities of practice" (Lave & Wenger, 1991, p. 55). The concept of LPP "brings together the theories of situated activity and the theories about the production and reproduction of the social order" (Lave & Wenger, 1991, p. 47). Through this lens, Lave and Wenger looked at five cases of apprenticeship to study how membership in each community of practice evolved and what problems were associated with such evolution. The ethnographic studies involved Yucatec midwives in Mexico, Via and Goa tailors, naval quartermasters, meat cutters, and non-drinking alcoholics in Alcoholics Anonymous. From these studies, Lave and Wenger (1991) found that "the effectiveness of the circulation of information among peers suggests that engagement in practice may well be a condition for effectiveness of learning" (p. 93). Furthermore,

Mastery resides not in the master but in the organization of the community of practice of which the master is part... a decentered view of the master as pedagogue moves

the focus of analysis away from teaching and onto the intricate structuring of a community's learning resources. (p. 94)

This leads us to distinguish between a learning curriculum and a teaching curriculum... A learning curriculum is a field of learning resources in everyday practice viewed from the perspective of learners. A teaching curriculum, by contrast, is constructed for the instruction of newcomers.... The learning curriculum ... evolves out of participation in a specific community of practice...and is essentially situated. (p. 97)

In situated learning, an individual develops knowledge and skills in the context that reflects how knowledge is currently "picked-up" and applied in the real world. We can say it is "learning by doing real work" that involves other learners, an authentic environment, as well as the complexity and ambiguity of learning in the real world. "Participants will create their own knowledge out of the raw materials of experience" (Stein, 1998, ¶1). For example, if one is to become a computer programmer (an occupation), s/he should learn to do things that professional programmers do on a daily basis, like maintaining production programs, communicating with users, and working as member of a project team, all mediated by tools and languages of that profession.

Situated learning poses a challenge for IT education in a school context. Schools, whether universities or vocational career colleges, prepare the bulk of new entrants into the IT profession. But by their very nature, schools could hardly be considered an <u>authentic</u> context. Although schools are communities, they are not a community of practitioners. The challenge for IT educators is to "operationalize" situated learning by somehow bringing

authentic context and community into the school world. Cognitive apprenticeship is one way through which situated learning can be operationalized in a school context.

2.9 Cognitive Apprenticeship Model

The cognitive apprenticeship model was first conceptualized by Collins, Brown, and Newman (1989) based on the conceptual work done earlier by Brown, Collins, and Duguid (1989). The model also has precedent in John Dewey's progressive education, Lave's (1988) observations of traditional apprenticeship, as well as Vygotsky's learning in the ZPD. Lave (1988) observed that apprenticeship is always a way of life where work, play, and life are intertwined, rather than a system of schools, curriculum, and teachers. Traditional apprenticeship is a process of being inducted into a community of practitioners (Berryman & Bailey, 1992), and as pedagogy, it shows us what effective learning looks like.

However, traditional apprenticeship is most effective in learning skills that are physically observable, such as carpentry, tailoring, and cooking. But the work world today is far more complicated. One cannot learn computer programming, algorithmic problem solving, and such from a master practitioner primarily by observation since much of the mental processes are invisible. Based on traditional apprenticeship, Collins, Brown, and Newman (1989) developed a model, cognitive apprenticeship, whereby cognitive skills can be apprenticed as well. The four building blocks of cognitive apprenticeship addressed the content, methods, sequencing, and sociology of learning. Berryman and Bailey (1992) further elaborated on these four components in their study on effective learning for today's workplace.

2.9.1 Content

Content should include both <u>domain knowledge</u> and <u>strategic knowledge</u>. Traditional learning focuses only on the facts, concepts, and procedures of a particular subject. Strategic knowledge includes tricks of the trade, cognitive management strategies, and learning strategies. This kind of knowledge is generally <u>implicit</u> in a community of practitioners because the knowledge is highly situated. Above all, strategic knowledge must include nurturing the habit and ability to keep up with all the changes in the professional environment: in other words, learning how to learn. For example, most programmers' day-to-day work involves performing maintenance and debugging of existing software rather than developing new software. However, most official IT curricula do not address these tasks in any depth. Where maintaining and debugging software is concerned, many tricks of the trade are highly dependent upon specific operating systems (e.g., Linux or Windows) and software development tools used in constructing the software in the first place. This knowledge is usually implicit in various user groups and communities.

2.9.2 Methods

Teaching methods should be designed to give students the chance to observe, engage in, invent, or discover <u>strategic knowledge</u> in an authentic context. Methods that have proven effective include modeling, coaching, scaffolding and fading, articulation, reflection, and exploration. Articulation does not mean lecturing. It merely means that, while an expert is modeling a problem solving process to an apprentice, s/he should verbalize those processes that are not immediately visible to the naked eye. For example, when students can work alongside the teacher in an authentic consulting project, the teacher will be able to provide coaching and modeling more readily than in a lecture setting.

2.9.3 Sequencing

Traditional school curricula usually sequence learning based on decomposing the subject matter into logical segments. I call this <u>subject-based</u> sequencing. Here, students are expected to master a subject rather than perform a meaningful task. Cognitive apprenticeship favors a <u>problem-based</u> sequencing of learning where the problems become increasingly complex and diverse and span multiple subject domains. From an IT curriculum point of view, learning would not be sequenced "logically," such as input, processing, and output. Instead, sequencing would be along increasingly complex tasks such as <u>using</u> software, <u>maintaining</u> software, <u>constructing</u> software, and <u>designing</u> software.

2.9.4 Sociology

The learning environment should reproduce the technological, social, motivational, and frustrating characteristics of the real-world situations where the learning is applied (Berryman & Bailey, 1992). In other words, the school should model and be connected to the workplace as much as feasible by situating learning in the real world. Besides learning from each other, students are also connected with and learn from the larger community of practitioners. For instance, students can work in Joint Application Development (JAD) teams to complete real-world software projects. They are given academic credits for activities in professional associations like the Canadian Information Processing Society (CIPS) or Data Processing Management Association (DPMA).

Both traditional apprenticeship and cognitive apprenticeship challenge current practices of professional IT education. Most people enter the IT profession by way of traditional school-based programs--computer science, MIS, and vendor certification programs. The academic environment generally enforces certain norms or practices for all

programs within that environment, regardless of whether the program is IT or English literature. Many of these practices are incompatible with our understanding of cognitive apprenticeship. For example, lecture as the dominant method of instruction, compartmentalization of learning by subject, the use of predominantly academics as instructors, and the use of exams as the primary means of performance assessment all contribute to a less effective educational experience.

2.10 Community of Practice Model

The term "community of practice" was used extensively in the theoretical work of Lave and Wenger (1991) on situated learning. However, Lave and Wenger (1991) used it only as a conceptual tool rather than a learning framework. Wenger went on to elaborate on CoP as a learning framework to inform practitioners of organizational learning and development. Its emphasis on human agency in learning slowed its reception in the more structured world of adult education (Merriam, 2001). Basically, a CoP is a group of people informally bound together by shared expertise and passion for a common goal. For example, many IT CoPs are built around the "open source movement" in software like the Linux and Apache communities. CoP "can drive strategy, generate new lines of business, solve problems, promote the spread of best practices, develop people's skills, and help companies recruit and retain talent" (Wenger & Synder, 2000, p. 1).

CoP-like communities have flourished in academia for many years, supported by a system of peer-review, journals, conferences, and Internet listservs. Participants in business and government COPs were learning by focusing on problems that were directly related to their work (Wenger & Snyder, 2000). Take, for example, the community of people who fix Xerox machines. Repairing large Xerox copiers involves much tacit knowledge--know-how

not documented in service manuals. At Xerox, service reps come together--over breakfast, at breaks, at the end of the day--and talk about their own best practices. Furthermore, Xerox has set up a process similar to an academic peer-review system to gather, screen, and share those best practices across the company (Brown & Duguid, 1989). CoP also plays an important role in the World Bank where practitioners of economic development share high quality information and know-how. The bank funds over 100 CoPs, and these communities, in turn, contribute increasingly to the bank's strategic direction (Wenger & Snyder, 2000).

Wenger (1997) posited a framework to guide learning in a CoP. I found that these principles echo the constructivist philosophy and raise a number of questions for IT educators:

- 1. View learning as work and work as learning. This is an assertion of Dewey's antidualism educational philosophy.
- 2. Count on the informal. This is where work gets done.
- 3. If there is a learning problem, look for patterns of social participation and exclusion.
- 4. Be suspicious of any process that attempts to extract knowledge from the communities of practice where it is kept alive, to transform this knowledge into a curriculum, and to deliver it outside of practice.
- Encourage the formation and deepening of communities of practice by legitimizing their work.

2.11 Summary of Situated Learning and Implications for IT Education

In this section, I have examined how the basic arguments of Piaget, Vygotsky, and Dewey were elaborated into the theory of <u>situated learning</u> by Brown, Collins, Duguid, Lave,

and Wenger. In situated learning, the learner develops knowledge and skills in the context that reflects how knowledge is "picked-up" and applied in the real world. To operationalize situated learning, Collins, Brown, and Newman (1989) developed the pedagogical model of cognitive apprenticeship. This model adapted traditional apprenticeship of manual skills like carpentry and tailoring to more "cognitive" skills. Wenger also operationalized situated learning in the organizational learning realm by developing <u>Community of Practice</u> as an organizational learning framework. CoP released the natural energy of learning from the rigid structures of the school, the syllabus, and the lecture. CoP not only legitimized the informal, the spontaneous, and the emergent but also developed a framework whereby learning can be nurtured, grown, and used to create synergy in an organization.

The models discussed in this section are compatible with the culture of information technology. Here, learning and working are inseparable acts. Practitioners experience this everyday. The question remains, how do we make school learning more like work and keep workplace learning from taking on the look and feel of schools?

2.12 Constructivism in IT Education: Recent Research

A search on the UMI dissertation database only yielded a handful of research related to the application of constructivism in higher or adult education. In the following section, I examined three doctoral dissertations that applied constructivism to some aspect of IT education and training. Through this review, I avoided "re-inventing the wheel" while I gleaned concepts to inform the principles advanced in this study.

2.12.1 Teaching Computer Mastery

Luterbach's 1997 dissertation is titled <u>Refining Instructional Design Theories: A</u> Comparison of Constructivist Instructional Strategies for Teaching Computer Mastery. In

this quantitative study, Luterbach compared three groups of undergraduate students in a fouryear college who were taught by different instructional methods in an introductory Computer Mastery course. He randomly divided 59 students into three groups of 22, 18, and 19 each. The control group was instructed in the traditional lecture/demonstration method. The two other classes, BIG and WIG, engaged in constructivist instruction, which included using authentic business computing problems and collaborative solutions development. Students in the BIG (Beyond the Information Given) constructivist classes were first given a conceptual outline of what computer mastery is all about. Students in the WIG (Without the Information Given) constructivist class proceeded to learn without the benefit of the broad perspective provided by the outline of computer mastery. Most of the post-test measures and the works submitted revealed few differences between the groups. However, in the post-test concept maps, the BIG group scored significantly higher than the WIG and control groups. As a result of this study, Luterbach prescribed a framework that includes presenting a conceptual overview, modeling mastery behavior, direct feedback, and opportunities for students to practice in simulations or with practitioners.

2.12.2 Technology and Software Training

Ulmer's 1999 dissertation is titled <u>Technology and Software Training: The Perceived</u> <u>Effectiveness of Using Constructivism, the Pause Principle, and Teams Composed According</u> to Psychological Type to Learn Computer Software Application. This qualitative study investigated and compared the perceived effectiveness of three instructional strategies for software training. This study involved 16 students in a computerized accounting survey course. The students maintained electronic journals, completed a Pretraining Survey and a

Training Effectiveness Survey. In addition, researcher observations were maintained in a field log.

The first strategy was the use of authentic projects where students learned computerized accounting by working collaboratively on real-world business projects. The second strategy is known as the pause principle. This concept is based on studies by Rowe (1980) and Ruhl, Hughes, and Schloss (1987) who found that retention and learning improve when learners are given a pause in which to work together to reflect on and summarize lecture material. Finally, the effectiveness of teams based on Jungian psychological types was also studied. The researcher believed that "Jung's (1971) theory of psychological types can provide insight into human-computer interactions, learning styles, and collaborative learning" (Ulmer, 1999, p. 7). Qualitative data analysis performed on the journals and surveys revealed that of the three instructional techniques investigated, authentic projects was the only technique that 100% of the respondents would like to use when learning software in the future. Benefits of authentic projects included deeper understanding and better retention of material. Ulmer (1999) also implied that authentic projects may assist in making the transition from generating information to creating and using knowledge, which is consistent with situated learning theory (p. 166).

2.12.3 End-User Computing

Bartfeld's 1999 dissertation is titled <u>Towards a Model of Responsive Training for</u> <u>End-User Computing: A Constructivist Approach to End-User Training</u>. By <u>responsive</u> <u>training</u>, Bartfeld referred to the kind of informal learning computer end-users do all the time. One can call it the "ask Fred" method of training. This study examined effective and ineffective training methods and defined a constructivist model for <u>effective responsive</u>

training (ERT). Although my own practice involves and the emphasis of my thesis is on the training of IT professionals, Bartfeld's study is informative to this thesis as she explored some of the debates common to all adult IT learning situations. In particular, Bartfeld analyzed the arguments between the two major IT training approaches--the product-oriented approach and the <u>user-oriented</u> approach--which she sees as "part of the controversy between behaviorism as the theoretical background of instructional design system and constructivism as the foundation of learning" (p.157).

Bartfeld developed the Effective Responsive Training (ERT) Model on a constructivist foundation. This model has three aspects: the content, method, and environment for ERT. The framework supported maximum user control, learning by doing, incremental learning processes, conceptual modeling, and even friendliness and emotional support. In terms of a constructivist learning environment, Bartfeld concurred with most constructivists in emphasizing the need for global (versus local) activities, an authentic learning environment, and ownership of learning by the learner. In addition, three more environmental principles emerged from her study: safety, relaxation, and freedom to explore as well as the trainer-trainee "contract" (p. 182).

2.12.4 Summary and Gaps

In this section, I briefly reviewed three recent research studies on the application of constructivism to some aspect of adult IT education. Luterbach studied how undergraduate computing students responded to different instructional treatments--constructivist and traditional. Ulmer confirmed the perceived effectiveness of authentic projects for technology and software training. Finally, Bartfeld examined effective and ineffective computer end-

users' training methods and defined the elements of effective responsive training as a constructivist training approach addressing the user's problems and needs.

While the principles advanced by each study have been useful in a classroom context, there remain considerable opportunities for further research in the application of constructivism to adult IT education. First of all, the studies of Luterbach and Ulmer concerned the effectiveness of constructivist instructional strategies at the course level. This kind of learning is still concerned with the transfer of knowledge or skill structures as selfcontained entities to individual students. They do not unleash the power of environment, context, tools, or community in learning. Neither do they address ethical and cultural issues in IT education. The full potential of constructivist IT education needs to address the program and institutional level first. There is still a need for a set of constructivist principles to guide how professional IT educational programs should be conceived. Bartfeld's study shed light on effective practices for end-users in a community of practitioner context. Still, there remains an opportunity for research into effective professional entry IT education.

2.13 Critiques of Constructivism

Today, the term "constructivism" stirs up different emotions with different audiences. As Burbules (2000) observed, people attach different meanings to the concept and fight vigorously to defend their ground. Some educators reject <u>pedagogical constructivism</u> because they fear that the ideas of <u>philosophical constructivism</u> could be attached to it. These ideas may lead to the limitations of scientific knowledge and of relativism (Burbules, 2000). However, IT educators considering constructivism will face practical problems. The following section explores these problems by reviewing the literature.

2.13.1 Biologizing or Tooling the Mind

Although Egan's (2002) critique of Piaget and Dewey's influence on progressive education applied mainly to the education of children, it is still noteworthy to mention his arguments against genetic epistemology. Egan connected Piaget's theory on the development of the mind with Herbert Spencer's discredited theory of recapitulation. Egan claimed that Piaget "over-analogized" the development of the mind with evolutionary biology, which led to a false belief in what children can do or cannot do at certain stages of development; somehow, natural ways of learning are always more effective than rote learning. Egan also pointed out some serious flaw in Piaget's research method where he studied children as though they were Neanderthal men.

Since this study concerns adult IT education, I did not find Piaget's evolutionary assumptions relevant. In fact, my own worldview does not even include Darwinian evolution, and as such, I have already discounted Piaget's explanation of the development of human intelligence. Nevertheless, the concepts of <u>assimilation</u> and <u>accommodation</u>, as descriptions of the human adaptation, can stand alone and apart from the theory of evolution. One can say that this form of human adaptation is even more observable in the mental realm than in the physical realm. I can see myself, my Uncle Ted, and others around me assimilating to reality more readily than I can see biological adaptation in humankind. Furthermore, genetic epistemology helps us to see the evolutionary state of knowledge so that we can understand it from a historical-cultural perspective.

By the same token, I agree with Egan's embracing the Vygotskian concept of equipping the mind with conceptual tools as a task of educators. Tools can help us overcome our natural limitations, both in the physical and intellectual realms. However, one can equally

ask whether conceptual <u>tools</u> are really <u>tools</u> at all? In my world of software engineering, a tool like a compiler or code generator is supposed to produce highly consistent outcomes each time a person employs it. Conceptual tools share none of the characteristics of tools in my professional cultural context. Rather, the conceptual tools referred to by Vygotsky (1978) or Brown (1989) are means of creation and not means of production. Again, the point is not to take these analogies too far.

2.13.2 "Ornamental" or Utilitarian Curriculum

Egan (2002) was equally critical of Dewey's theory on curriculum, again, by tying Dewey to Spencer. Egan challenged the assumption that a utilitarian curriculum built around the real world is somehow better than a classical or "ornamental" curriculum that includes subjects like Latin and Shakespeare. Again, much of the criticism was directed toward the way children are learning in schools today and is not directly relevant to this study. However, it did raise a number of questions for university-based IT curriculum as we move to examine dominant practices in the next chapter. For example, should university programs be serving the economy? Should businesses have a strong say in university IT curriculums? These questions bring us to the next issue: learning versus performance.

2.13.3 The Problem of Learning versus Performance

Adult IT education is situated in the worlds of postsecondary education and human resource development (HRD). Here, the outcome of learning must demonstrate some acquisition of or improvement in workplace competency. IT is intrinsically performanceoriented. It is used to keep planes flying safely in the skies, to bring trains into their stations on time, to let people withdraw cash from neighborhood ATMs, and so on. In this world, what constitutes acceptable outcomes is highly objective and cannot be broadly interpreted.

On the other hand, adult education is a broader field of practice and is based on the belief that education should be used to maintain a democratic society, which is best accomplished by preparing citizens to participate through education (Swanson & Holton, 2001).

The debate seems to centre on the issue of whether expectation of performance as an outcome of learning is good or bad. No one seems to deny that learning for its inherent value is a good and humanistic endeavor. However, performance-based HRD is based on the belief that "<u>both</u> learning and performance are inherently good for the individual because both are natural parts of human existence. It is hard to imagine a life without learning or without performance" (Swanson & Holton, 2001, p. 134). Since the ultimate purpose of HRD is to improve the performance of the organization, it has to consider both learning and non-learning interventions. Learning HRD advocates (Barrie & Pace, 1998) argued for a more educational approach to HRD. They perceived the performance paradigm as the root of all negative effects of training since it treats the learners purely as "means" and not "ends."

2.13.4 The Problem of Different Perspectives on Teaching

When adult IT education is carried out within a higher education setting, learning is primarily mediated by professional teachers and instructors. One cannot assume that the constructivist view of teaching and learning can become a <u>de facto</u> model of instruction across a broad range of contexts and educators. Pratt and Associates (1998) in <u>Five</u> <u>Perspectives on Teaching in Adult & Higher Education</u> documented five different perspectives, namely transmission, developmental, apprenticeship, nurturing, and social reform. Most educators hold only one or two perspectives as their dominant view of teaching. These deep-seated personal belief-structures are formed over a long period of time and give us a kind of "teaching personality." One does not choose a perspective, just as one does not

choose his or her personality or worldview (Pratt, 2002, p. 202). Since constructivist assumptions are reflected in mainly two of the five perspectives on teaching--developmental and apprenticeship--we can assume that IT educators holding other perspectives will naturally resist a "one size fit all" constructivist-based paradigm. So, is a constructivist paradigm a lost cause for the teachers who hold other perspectives? Observation and research have given us cause for optimism as we can often see teachers using typical strategies in differing perspectives. For example, a <u>developmental</u> teacher can also be a great lecturer just as a <u>transmission</u> teacher can facilitate discussion and projects and facilitate them very well. For a constructivist model to become successful across a school, leaders have to be fair to and respectful of teachers with different perspectives and provide appropriate instructional development and support (Pratt, 2002).

2.13.5 The Problem with e-Learning Design

A large part of the \$39 billion IT education and training industry mentioned earlier is made up of e-learning products and services such as computer-based training (CBT) and web-based courses. These products are taken from concept to market through a rigorous engineering process. The instructional design (ID) process is critical to any successful product. After examining the concept of situated learning, Orey and Nelson (1994) observed that integrating the principles of situated learning into current instructional design practice would not be easy. They concluded, "There are too many problems involved in trying to make explicit the knowledge of experts, to abstract that knowledge, and to communicate the knowledge to novice learners" (p. 627). Although Internet technology supports many online communities of practice, it is questionable whether situated learning, as a theory, could underpin future e-learning products the way rational-technical theories have done in the past.

In this section, I discussed five problems with constructivism from reviewing literature sources. I selected these issues from educational, corporate, and e-learning domains as they correlate with problems I have experienced in practice. In order for the proposed principles to be useful to the broadest range of IT educators, I have to consider these problems and address them appropriately.

2.14 Summary and Conclusion of Literature Review

I began^t this review guided by two purposes: understanding the basic arguments and pedagogical implications of constructivism and locating gaps or opportunities for research into the application of constructivism to adult IT education. I reviewed literature on the philosophical roots of constructivism, focusing on the classical works of Piaget, Vygotsky, Dewey, and Freire. I examined situated learning, a theory that is built on the philosophical foundation of constructivism. Furthermore, I discussed two situated learning models-cognitive apprenticeship and community of practice--that reflect constructivism. I reviewed three research studies on the application of constructivism to IT training and education and found that opportunities for research still exist in the realm of professional IT education. Finally, I discussed some problems of constructivism from educational, organizational, and instructional design points of view.

A reflection on the literature revealed nine characteristics of constructivist learning with application potential to adult IT education. These guided the study into the next three chapters:

1. Reality--Practice should reflect the complexity of reality, rather than oversimplifying reality through objectification and reduction.

- 2. Environment--Practice should utilize the already favorable context for IT learning instead of creating an artificial environment that is out of sync with reality.
- 3. Mediation---Mediation should be multifaceted, multimedia, and multidimensional, utilizing the real world, real tools, and authentic problems.
- 4. Integration--In university IT programs, workplace ethics and moral values integration should be evident.
- 5. Politics--Practice should negotiate through the power and interests that could keep it from becoming effective.
- Community--Practice is integral to active membership in a community of practitioners.
- Knowledge--Practice should take into account the importance of strategic or tacit knowledge and not be fixated on the acquisition of domain or product knowledge.
 Most importantly, practice should take into account the velocity of change in IT knowledge.
- 8. Performance--Practice should reconcile both the need for learning and performance.
- 9. Perspective--Practice should not marginalize but should empower practitioners from differing teaching perspectives.

These nine characteristics of constructivist learning, distilled from the literature, serve as a set of benchmarks against which dominant practices in IT education can be critically examined in the following chapter.

3 DOMINANT PRACTICES IN IT EDUCATION

This study now moves from a critical analysis of literature to a reflection on practice. To improve practice, one has to first understand practice. What drives IT education and training today? What are the assumptions behind current IT educational models? What are their strengths and weaknesses? How do constructivist theories challenge the current practice of adult IT education? How can constructivism enhance current practices? The method of inquiry here is the examination of artifacts representing discourses which frame IT educational practices in two principal domains: the university and the workplace. Pratt describes "discourse" as a "means by which a group actively shapes and orders their relationship to the social world. In so doing, they also establish boundaries that further define authority, membership, identity, and legitimacy in a community of practice" (Pratt & Nesbit, 2000, ¶5). From the artifacts, I have chosen to (a) examine the defining standards for practice and their underlying assumptions, (b) raise questions of validity and effectiveness, and (c) explore the potential of constructivist principles to transform practice.

3.1 Academic Artifacts

For the purpose of this study, I chose to examine the Association for Computing Machinery (ACM) Information Systems 2002 Model Curriculum (from here on referred to as IS 2002) as representing a significant discourse on university-based IT education. Founded in 1947, the ACM is a major force in the IT profession worldwide. ACM convenes various task forces to produce IT curriculum recommendations for all schools and colleges in the US and Canada. Both the academy and industry are well represented on the curriculum committee. Compatibility with IS 2002 is a main consideration when schools apply for professional accreditation.

3.2 The IS 2002 Standards and Assumptions

The educational goal of IS 2002 is to produce graduates equipped to function in entry level IT positions. The curriculum responds to industry requests for both increased emphasis in technical knowledge, communication, problem solving and critical thinking skills (Appendix B). As an IT educational framework, the IS 2002 does the following:

1. Provides a set of principles to guide curriculum design.

- 2. Defines the scope of IS as a field of academic study.
- 3. Draws the relationship between IS core courses and other required courses.
- 4. Specifies faculty requirements for IS programs.
- 5. Provides guidelines for computing infrastructure requirements.
- 6. Positions its work as the basis for IS accreditation.

The predominant part of the committee's work concerns the content of the curriculum itself. The architecture of the curriculum (Appendix C) is organized bottom-up where 1000+ topics from the IS body of knowledge are organized into 100+ learning units. These units are, in turn, grouped into 10 courses in 5 presentation areas.

The curriculum is presented in the IS program (Appendix D) in a general sequence. Each learning unit builds on prerequisite learning from another unit. What are the theoretical assumptions of IS 2002? An analysis of the "Principles Guiding the Curriculum Design" (p. 5) can reveal much about the philosophy of this curriculum.

The first principle states, "The model curriculum should represent a consensus from the IS community" (ACM, 2002, p. 5). The curriculum committee seems to be guided by the political nature of program planning in what Cervero and Wilson (1994) termed negotiation of power and interests. In this case, nine professional organizations participated or

cooperated in this curriculum effort. The second principle states, "The model curriculum should be designed to help IS faculty produce competent and confident entry level graduates well suited to workplace responsibilities" (ACM, 2002, p. 5). The committee seems to subscribe to a <u>social efficiency theory</u>, which pays special attention to specific educational objectives based on job analysis in the workplace. On the other hand, given the need to balance the influence of the workplace and faculty freedom, the third principle states, "The model curriculum should guide but not prescribe. Using the model curriculum guidelines, faculty can design their own courses" (ACM, 2002, p. 5). The fourth principle states, "The curriculum should be based on sound educational methodologies" (ACM, 2002, p. 5). To reemphasize the practical and political nature of program planning, the fifth principle states that "the model curriculum should be flexible and adaptable to most IS programs" (ACM, 2002, p. 5).

So what are the methodologies used and recommended in this curriculum? IS 2002 uses a <u>behaviorist</u> approach where "Competency levels are specified for each included element from the body of knowledge. A sequence of behavioral objectives is provided within each learning unit. These objectives are written to describe a specific competency level. The objectives form the basis for assessment of student accomplishment" (ACM, 2002, p. 19). The five-level educational objectives metric (Appendix E) is based on Bloom's (1956) taxonomy of educational objectives.

The cognitivist assumption that "proper sequencing is an important factor in achieving student success" (ACM, 2002, p. 38) is also central to IS 2002. The sequencing guideline is based on the instructional design methodology of Gagne, Briggs, and Wager (1992), p. 19).

In terms of instructional strategies, IS 2002 recommends different learning techniques for developing five different levels of competencies. Lecture and structured lab methods are recommended for Levels 1 (awareness) and 2 (literacy) learning. Level 3 (usage/comprehension) requires "considerable practice and creative repetition" (ACM, 2002, p. 38). It considers teamwork, project work, and other participative learning strategies essential in achieving Level 4 (application) competency (ACM, 2002, p. 38-39). When it comes to the advanced competencies defined in Level 5 (analysis, synthesis, and evaluation) IS 2002 does not have any specific instructional strategy to offer.

3.3 A Critique of IS 2002

IS 2002 represents a negotiation activity of monumental proportion, and ACM deserves credit for its effort. The integration of ethical principles into the curriculum is also laudable. Nevertheless, some major problems exist from both educational and pedagogical perspectives. As a result, what IS 2002 provides is a recipe for "more of the same" in university IT education.

3.3.1 Educational Perspective

As a start, the ACM has adopted a very limited view of who "the IS community" is as some organizations are excluded from the process. Planning a university-based program could be a substantively democratic process (Cervero & Wilson, 2006, p. 4). However, by addressing only the interests of professionals and their employers, IS 2002 arbitrarily limits the IT problem-solution domain. In reality, the pervasive use of IT is a powerful force of change in society today. The proliferation of IT into the workplace and into everyday life has resulted in health problems, socio-economic problems, and geopolitical problems. Organizations such as unions, economic development agencies, mental health associations,

and small business associations are all working to cope with this change. Their voice can inform curriculum designers of a much richer meaning of the term "solving real world problems" and help develop leaders who can build a different world. Furthermore, a limited view of the IS community also limits the kind of students university IS programs can attract.

Secondly, by focusing the inquiry on who can be hired tomorrow, IS 2002 missed out on lessons from those who were fired yesterday. IT employers are notorious for using and disposing of human resources. For example, the Information Technology Association of America (2002) reported that in 2001 U.S. firms hired 2.1 million IT workers but also dismissed 2.6 million IT workers. Furthermore, ITAA found that whether the IT job market is up or down, approximately half the positions will go unfilled because of a lack of applicants with the right skills. This phenomenon hints of underlying problems in collegebased IT programs, the main source of IT professionals according to the ITAA. Why does professional obsolescence happen so quickly to IT workers? Is this related somehow to the way they were trained? How could college students develop adaptation abilities for the changing work place?

3.3.2 Pedagogical Perspective

The IS 2002 planners viewed instruction as, primarily, a body of knowledge to be taught in elaborately sequenced learning units and courses. On the other hand, the theory of <u>cognitive apprenticeship</u> informs us that <u>prior experience</u> is more important than <u>prior</u> <u>knowledge</u> in solving real world problems. The IT professional is often called upon to solve problems where s/he has no prior knowledge whatsoever. A curriculum that is built substantively on prior learning assumptions will impart an unrealistic view of the IT workplace to students, leading to early professional frustration.

Secondly, the so-called "IT body of knowledge" is not authentically situated. The authentic artifacts are the various IT standards and related documents, which change constantly. Therefore, an effective IS curriculum should aim for <u>change-adaptive qualities</u> rather than <u>knowledge quantities</u> in its graduates. Finally, this body is arbitrarily divided into courses such as Hardware, Programming, Analysis, and so on. In real life IT, these branches of knowledge are highly integrated as well as tacit in nature. In short, the most important difference between a subject-based and a problem-based pedagogy is while the former teaches students to <u>develop the program</u>, the latter aims to <u>develop the programmer</u>.

3.4 Corporate IT Education Artifact

Corporate IT Education and Training (ITE&T) is a significant sector of organizational learning and has many faces, commonly seen in the form of vendor products training (e.g., Microsoft Office or Oracle Financial). Then, there is performance support (e.g., call center staff helping customers to solve problems on 1-800 hotlines). In addition, many soft skill courses like Software Engineering and Communication Skills are available.

While university-based IT education affects thousands of students at a time, organizational learning (OL) touches millions of workers throughout their lives. OL shares many of the theories, methodologies, and problems of education. From a Dewian point of view, it does not make sense to maintain this Chinese wall between the two worlds where, in fact, these two solitudes are moving closer and closer together. Consider that universities are now granting academic credits for computer vendor product courses; corporations are outsourcing IT and other training to universities; and both entities are actively building a standard to share common learning objects.

While IS 2002 is formed by consensus, the discourse in the IT training industry emerges from a culture of competition. With the advent of the World Wide Web in the late 90's, e-learning became the rage. However, education providers have realized that, although most learners like the flexibility, control, and economy of e-learning, human mediation is still important. Thus, discussion around the concept of <u>blended learning</u> in the organizational learning space is ongoing. The term <u>blended learning</u> generally refers to using a combination of pedagogies, e-learning, and face-to-face training to accomplish an educational goal (Driscoll, 2002). For the purpose of this study, I examined the 4-Tier Blended Learning Model from IBM (Appendix F) as representing the current discourse on blended learning.

3.4.1 IBM 4-Tier Blended Learning Model

According to IDC, IBM Global Services, with close to half-a-billion dollars in training revenues, is the second largest IT training company in the world. While the IS 2002 curriculum is based on <u>elaborating subject matter knowledge</u> from general to specific, the IBM strategy is based on <u>elaborating social interaction</u>. More specifically, the four tiers are as follows:

Tier 1: Learn from Information--Basic information transfer requires only interaction between the learner and various online or offline performance supporting materials like books, videos, web pages, and presentations.

Tier 2: Learn from Interaction--Basic skills acquisition requires repetitive interaction between the learner and different multimedia learning tools like CBT/WBT, simulations, and games.

Tier 3: Learn from Collaboration--As a learner moves towards application of the basic skills, s/he begins to interact with online instructors and peers through the use of chat rooms, discussion forums, live virtual classrooms, and other collaborative technologies.

Tier 4: Learn from Co-location--Finally, as a learner progresses towards advanced application and mastery of a skill, the need for more personal interaction with the instructor or mentor in a face-to-face situation increases. Here is also where tacit or informal knowledge is transferred.

3.4.2 Theoretical Assumptions of the IBM Model

Obviously, the IBM Model blends different instructional technologies with face-toface instruction; but more importantly (for this study), it is an attempt to combine various pedagogical approaches to produce an optimal learning outcome. We shall examine how the major discourses on learning are blended in the model.

First of all, the <u>cognitivist</u> view of learning as information processing lays the groundwork at Tier 1. The learner starts off by receiving information through reading, listening, or watching relevant materials. Computer simulations used in Tier 2 further help the learner to visualize difficult concepts and to deepen understanding. Throughout the framework, the emphasis of a learner-centric, learner-controlled approach echoes the arguments of <u>andragogy</u>.

The model shares the <u>behaviorist</u> view of a hierarchy of learning objectives--from information transfer, through skills application, and into knowledge creation. The hierarchy correlates, more or less, with Bloom's six-level taxonomy of behavioral objectives. Also, the model recommends the use of CBT/WBT and interactive games as means to acquire and practice basic skills.

The <u>constructivist</u> pedagogy of collaborative learning is at the heart of the IBM model. It sees interaction with peers, mentors, and instructors as key to learning higher-level skills. Tier-3 is all about collaborating technologically through virtual teams, e-Labs, web conferences, and so on. Finally, Tier-4 emphasizes face-to-face collaboration and the exchange of tacit knowledge through informal learning encounters. Thus, as a learner moves up the educational scale, s/he must simultaneously move up the collaboration scale.

The learning model white paper and the operational examples from IBM seem to imply that learning moves along a linear path. It begins with <u>explicit/formal</u> knowledge and moves towards <u>tacit/informal</u> knowledge. Concurrently, the instructional process moves from <u>learner-centered</u> to <u>learning-team centered</u>. Similarly, mediating technologies move from mostly <u>interactive</u> to more <u>collaborative</u>. In terms of performance over time, <u>knowing</u> precedes <u>doing</u>, and <u>doing</u> precedes <u>adapting</u> (Grebow, 2002, p. 5). Thus, the IBM 4-Tier Blended Learning Model can be called a <u>cognitivist</u> pedagogical framework with <u>behaviorist</u> and <u>constructivist</u> elements.

3.4.3 Critique of the 4-Tier Model

A real-world organizational learning model is always a compromise between what is <u>valid</u> and what is <u>viable</u> for that organization. IBM developed the 4-Tier model, first and foremost, for IBM's own learning needs. Even for such a highly profitable company, <u>time</u> and <u>money</u> are huge determining factors of what is educationally viable. For example, IBM reaped total benefits of over \$88 million by using the 4-tier model in just one training program alone (Nucleus Research, 2002, p. 3). Even so, to what extent can the IBM Model be applied across organizations? The review of this model raised some questions.

First, I questioned the way collaborative learning is sequenced in the model. It seems to imply that social interaction is not necessary in the early stages. A learner would do well by interacting with books, self-paced learning materials, and computer simulations. Human mediation and collaboration, whether face-to-face or online, is to be deployed only in later learning stages. This approach runs contrary to the cognitive apprenticeship idea of <u>scaffolding and fading</u>, (Berryman & Bailey, 1992, p. 91) an effective learning strategy where more direct support is given to the learner upfront. In my experience with IT skills development, upfront coaching and modeling are critical.

Secondly, I question the "knowing-doing-adapting" order implied in the model. Piaget would say that <u>adapting</u> is in the human genes. Knowledge is constructed from things we do to ensure survival and to make sense of what is happening in the world. On the surface, this may seem like a pure epistemological argument. However, it does seriously affect performance and adaptation. The IBM model organizes learning in terms of subjects of knowledge (subject-based learning). This kind of learning creates what Pfeffer and Sutton (2000) call a "knowing-doing gap" (p. 6). In my own experience, subject-based learning also creates a "doing-adapting gap" in IT professionals as well. They feel the need to "go back to school" in the face of every disruptive technological or environmental change. However, if <u>learning</u> is organized around problems-- <u>doing</u> things necessary to <u>adapt</u> to problems--there will be less of a "knowing-doing" or "doing-adapting" gap.

3.5 Strengths of Dominant Practices

Both the ACM and IBM models possess obvious advantages over the constructivist models of cognitive apprenticeship and community of practice (CoP) discussed in the literature review. What then is gained by sacrificing authenticity?

3.5.1 Scalability

First, these models are far more scalable than the constructivist models. According to the National Center for Educational Statistics, colleges in the U.S. granted over 36,000 bachelor degrees and 20,000 associate degrees in Computer and Information Sciences in the year 2000 (NCES, 2003). I seriously doubt that industry on-the-job training could get anywhere close to those numbers. Scalability is, by far, the best reason for locating IT education in schools.

3.5.2 Familiarity

Having a clearly defined syllabus can also give a degree of comfort to students and teachers alike. Students always know what is expected of them in a school: attendance, participation, assignments, and exams. The syllabus tells them what will be covered and what is expected of them week-by-week. There are no surprises. Whereas on any given job, things change from day-to-day. Someone learning on the job cannot expect to have his or her duties laid out months in advance.

3.5.3 Availability

It is easier to be admitted into an IT study program in a school than to find an on-thejob training position in industry. Schools also have a ready supply of instructors to teach courses. Although college instructors may not always have current industry experience, many are practicing consultants or retired professionals. When IT became a university discipline, it also tapped into the research resources of universities. University research often does not have the same business constraints as industry research, allowing instructors pursue more abstract and imaginative ideas.

3.6 Summary

In this chapter, I examined two artifacts representing the current discourses in adult IT education. I analyzed representative artifacts for practice in college-based and organizational-based IT learning programs. Each model possesses obvious strengths. The IS 2002 has structured content and has meticulously categorized the explicit body of IT knowledge. On the other hand, the IBM Model accommodates variety. It legitimizes various instructional methods, technologies, and media. Together, they made IT education scalable, convenient, and available.

Even so, exceptional potential exists for constructivist principles to transform practice in at least three important ways. First, through its principle of education for the real world, constructivism can broaden the opportunities to be addressed by adult IT education. Current practices suffer from a restrictive worldview. The IS 2002 view revolves around the few technical and communicative competencies required by business. Business, on the other hand, is too focused on its search for a performance-enhancing steroid in blended e-learning. Meanwhile, according to CSC, the world's leading IT outsourcing company, 95 percent of the world's population has never used the Internet. Furthermore, "50 percent of the world's population does not have access to electricity and 42 percent of adults have never even heard a dial tone" (CSC, 2002, p. 84). Without a broader view of the problem domain, the growth rate of the IT industry and IT education will level off quickly.

Secondly, through its principle of organizing learning around problems instead of subjects, constructivism can make IT education delivery much more effective and efficient. Subject-based IT learning leaves me with the feeling of learning to cook chicken fried rice by studying the anatomy of birds. Real world IT is integrative. It blends hardware, software,

networks, data, and people into situated solutions. That is the way IT is used, and that is the way IT is best learned.

Finally, by emphasizing <u>exploratory</u> learning over <u>explanatory</u> learning, constructivist IT education can deliver more "experienced" graduates to the job market. Today, universities emphasize the understanding of a body of IT knowledge over the construction of knowledge through meaningful experiences. On the other hand, corporations have a ready-made experiential context for learning; therefore, they rely on technology to deliver knowledge to the learner with greater speed and flexibility. Even so, there is a need for a set of constructivist principles that could be "seeded" into both practices that could, over time, enhance the learning experience of all participants. As we shall see in the next chapter, these principles are not only informed by literature but also from a lifetime of experience as a learner, an IT professional and educator.

4 REFLECTIVE AUTOBIOGRAPHY

How can my own experience and the reading of theory coalesce into practical principles to guide adult IT education? Pratt and Associates (1998) posits that teaching perspectives do not come from any formal study on the subject but from one's cumulative experience as a learner. In essence, the constructivist principles in the following chapter are a set of teaching perspectives articulated after reflection. This chapter addresses three questions used in that reflective process: What kind of teaching perspective have I acquired? What kind of experiences in my life helped form that perspective? How does theory correlate with or challenge the underlying assumptions of my perspective?

I used Pratt's <u>Teaching Perspective Inventory (TPI)</u> instrument to identify my personal teaching perspective. The test revealed my dominant teaching perspective as Apprenticeship (39). My backup perspectives are Developmental (35), Nurturing (33), and Social Reform (32). My recessive perspective is Transmission (23). In this chapter, I have focused my reflection only on those experiences that best explain or challenge my dominant perspective (Apprenticeship) and my recessive perspective (Transmission).

4.1 Early Aversion to Transmission Education

Schools in Hong Kong, where I received my K-12 education, were very traditional with a great deal of memorization and regurgitation. Almost every report card reflected dismal failure. Although I was not into schoolwork, I was busy learning from activities outside school. I learned English informally by playing with foreign children in my neighborhood and was functionally bilingual before age 10. I loved going to church, too, as there were other kids to play with. Thus, English and religion were my best subjects. I enjoyed geography and history because they transported my imagination out of the confines

of tiny Hong Kong. In those years, my best teacher was really my father. He showed me how to fix cars. We built our own radios. He gave me old copies of <u>National Geographic</u> and <u>Popular Science</u> to read. I even started my own small business at age 16. I was learning a great deal, but not in school. My K-12 schooling left me with the impression that school was irrelevant at best and a tyrant at worst. This experience could bias me against the Transmission perspective of teaching.

4.2 Learning as Surviving

Life took a huge turn for me after high school. I was given \$500 and a one-way plane ticket to America to "swim or sink on my own." I enrolled in a college and tried to make ends meet by taking on two or three jobs at the same time, all year round. I was, at one time or another, a janitor, waiter, cook, security guard, cashier, upholsterer, sewer, door-to-door salesman, and so on. Thinking back, I believe what had kept my interest in academic studies during those years was the work world. Working in backbreaking, low-end jobs increased my motivation to get a good education. I came to believe that learning and earning must go hand-in-hand and that the work world offers much to learn.

4.3 Apprenticeship Experienced

Armed with a history degree in 1975, I worked at the City Hall of Greenville, South Carolina. As a janitor, it was my job to clean the room where the huge IBM mainframe computer sat. As I was interested in electronics, I would often hang around for hours asking questions. Through these informal encounters, I befriended George, the Data Processing Manager. Each evening after I was done with my janitorial work, I would stay and help George with his data processing work on my own time. At first, he only allowed me to "baby-sit" the mainframe while it ran in the evening. I reported problems in a logbook and

shut down the system when all the jobs were done. Soon, I was allowed to start more complicated jobs like printing checks and parking tickets. After a few months of "volunteering," George offered me a paid job at the department. He taught me how to program the computer so I could help him to clear up the backlog of software maintenance. I studied some IBM "programmed instruction" self-study courses. But, mainly, I learned from reading program code and asking George questions.

A year later I moved on to work as a computer programmer for a state university. Mark was my supervisor. Mark was a different kind of teacher from George but a good teacher nevertheless. He was man of few words. Whenever I had a problem with programming, he would point me to a solution similar to the one I was working on. So by reading all kinds of COBOL programs, I became a very proficient COBOL programmer. After a year, I felt that, professionally, I had moved from an apprentice programmer to a "journeyman." I felt that the most effective way to learn IT was really "on-the-job" learning.

4.4 Real World Complexity

Arriving as a new immigrant in Montreal in 1977, I took an IT job at a clothing factory. I was one of only two IT professionals there. Ian was my boss, and I felt that I could learn a lot from him. As it turned out, Ian was nothing like George or Mark. He was totally disorganized. Few things were ever documented, and all knowledge resided in his head. Without system flowcharts, operation manuals, or even up-to-date program listings, it was very difficult for me to learn what was going on. A couple months after I started, the company abruptly fired Ian for alleged drug problems. I was left running the whole show without any knowledge about how things worked. Within a few weeks, the system started to fall apart because no one knew which program to run to patch particular problems. Only Ian
knew, and he was gone. I had to learn very fast or find another job. I worked day and night for three weeks and read every one of the 450 programs. I was able to solve the more urgent problems and got the factory moving again. Within a few months, I achieved complete mastery of the entire IT system. I even made numerous enhancements to the system over the next year, was promoted to management, and was given a huge salary increase all within a year. In retrospect, I had gained years of experience in four long months. Once again, survival means learning and, often, learning fast!

4.5 From Journeyman to Master

In 1979, I joined the IT department of a large fishing company in Atlantic Canada. As I computerized the fish plants, I found that it was almost impossible to relocate IT professionals into these fishing villages. I had to train local workers, usually with only a high school education, to operate and maintain those sophisticated systems. However, when learning was framed by day-to-day work problems in the fish plant, I found that people learned and performed very well. As I watched how garment plant and fish plant clerks could become competent IT workers and as I reflected on my own IT career, I began to seriously question the efficacy of formal IT education of the day. I questioned learning IT in the absence of meaningful context. I questioned the university curriculum; it seemed like what was needed was never taught. I questioned the artificial entry barriers (such as math and science prerequisites) into the profession. I even questioned what does and does not "count" as learning. I began to think that the traditional educational system exists for its own sake.

4.6 **Reflecting Practice from Educational Theories**

In 1995, I enrolled in the distance M.A. in Educational Technology Leadership program at George Washington University. That was my first exposure to formal educational

theories, which helped me make sense of my past experiences. GWU is situated in the United States' capital and is a centre for policy studies. The experience raised my consciousness of the workplace's importance and its relationship with the school. I was especially influenced by three pieces of work: <u>The Work of Nations</u> (1992) by Robert Reich, then Secretary of Labor; the findings of The Labor Secretary's Commission on Achieving Necessary Skills (SCANS) (1992); and <u>The Double Helix of Education & the Economy</u> (1992) by Berryman and Bailey. I took two ideas with me from GWU. First, workplace competencies and skills (e.g., problem-solving, communication, etc.) should be purposefully integrated into academic studies. Secondly, constructivist pedagogies such as problem-based and collaborative learning hold enormous potential for IT education and training of the day. These ideas seemed to correlate with my past experience as an IT professional and evolved into deep beliefs about education.

4.7 **Practicing with Theory**

The time to test these ideas came in 1996. I was offered the position as the first Director of Instructional Design at ITI Information Technology Institute, a private trade school in Halifax. I was given a free hand to build a full-time, nine-month professional IT "conversion program." A conversion program takes university graduates from different non-IT disciplines and prepares them for entry-level professional jobs like computer programmers and analysts. The predominant instructional method throughout the IT training industry at that time was a programmed learning method, pioneered by software vendors like Microsoft and IBM. I developed an entirely new kind of curriculum by applying constructivist principles. Lectures were kept to a minimum. Students worked in small teams to design and implement real world IT projects. The outcome of the new curriculum was phenomenal.

Within four years, ITI became the largest source of new IT professionals in Canada. The school grew from one campus in Halifax to over ten campuses across North America. ITI became the first school to be listed on the Toronto Stock Exchange. Recruiters from all over North America flocked to our campuses for graduates to feed the seemingly insatiable appetite of the booming Internet companies.

Since 2002, I have used constructivist pedagogy in college-based IT courses and found it to be equally effective, even in China. Through a Christian volunteer service organization, I brought teams of professionals from different countries to teach an undergraduate e-Business survey course at universities in Sichuan and Chongqing. Although the volunteers have extensive professional experience in business and IT, most had never taught in a university context anywhere. Furthermore, there is always a language barrier since most Chinese students we have are generally weak in English (the medium of instruction), and most volunteers we have are weak in Chinese. However, by structuring the curriculum around a meaningful and collaborative project, both students and teachers share an exceptional learning and teaching experience each time. The theme for the course is Career Planning. Students learn e-Business by using the Internet to understand job requirements in the real world; they learn to prepare e-resumes; they work in teams to build a website to share their findings about employers and jobs; and they dialog with the volunteers about life goals and values while the volunteers coach them through the project in a cognitive apprenticeship. These courses have been running twice a year since 2002, and they are the highlight on campus. Teachers also enjoy this non-traditional form of teaching and volunteer repeatedly, year after year.

Can the constructivist model be used in a continuing professional education (CPE) environment? My experience with a CPE for high school teachers showed that it could be equally effective. In 2001, I was asked to take over a Hong Kong Department of Education funded CPE course that was running into trouble. It was a 40-hour course for schoolteachers titled "Coordination of Information Technology Across the Curriculum." Teachers are taught how to integrate the learning of IT into every subject that they teach (e.g., language, math, and social studies). Prior to my arrival, the course was run over four Saturdays (8 hours per session) as a lecture-based course with some research work on the Internet. Naturally, the teachers were in no physical shape to sit through hours of lectures on curriculum theories after a week of K-12 teaching. Course evaluation was very poor, and attendance was low. When I took over the course, I eliminated 80% of the lectures and asked the teachers to work in teams to produce an authentic curriculum product they could use (e.g., lesson plan, website, school, and projects). I only brought in theories at the appropriate stages of development. The teams then presented their products to the class for feedback and shared their product on a website with the rest of the world.

4.8 Challenges to Constructivism

4.8.1 Technical-Rational Constructivism?

Two curriculum alignment projects I worked on between 2003-2005 challenged some of my assumptions about constructivism. To some extent, my experience during this period caused me to rethink the applicability of the constructivist framework, which was first conceived in Canada, in an Asian or American higher education context. I spent a year as a Visiting Fellow at the Educational Development Centre of the Hong Kong Polytechnic University, the largest university in Hong Kong. PolyU had committed itself to a

constructivist teaching and learning environment and had even made Work-Based Education (WBE) mandatory for all students. However, the eight publicly funded universities in Hong Kong went through a Teaching and Learning Quality Processes Review (TLOPR) by the University Grants Committee, the government agency responsible for funding universities. The universities were given low marks on the coherence of their curriculum, especially coherence between mission and intended outcomes and between outcomes and assessment. Funding could be threatened if there were no visible improvement in the future. To remedy the situation, PolyU initiated a wholesale move to Outcome-Based Education (OBE) under the direct leadership of the Vice President of Academic Affairs. All departments were required to review their programs and submit curriculum revision documents for endorsement by the Faculty Board. My work was to develop the curriculum guidelines and resource materials to support the curriculum revision efforts of the departments. While WBE is highly compatible with my apprenticeship teaching perspective, OBE rests primarily on technical-rational assumptions. However, it gave me an opportunity to test the proposed principles and to understand how to use them within the structures of OBE.

At about the same time, I was also doing a similar project for an American university. The University of Dubuque (UD), where I am an adjunct professor, was preparing itself for regional accreditation review. The first criterion for accreditation is the Criterion of Mission and Integrity, which means the university should operate with integrity to ensure the fulfillment of its mission through all its structures and processes. UD, being a 153-year old Presbyterian school, has a mission to offer a value-laden education, which focuses on justice, ethics, and responsible stewardship. Since I was the only business faculty member with

substantial formal training in education, I was tasked with aligning every MBA course outcome with the University's mission and goals as well as with the MBA program goals.

These technical-rational projects challenged my own notion of constructivism in at least three ways. First, they provided an opportunity for me to implement the proposed constructivist principles within a structured environment. Once I tried to implement these principles, I became keenly aware of the importance of blending constructivism with rational-technical theories. Secondly, I became more aware that higher education could not be substantially guided by the workplace. A school is accountable to the institutions that started it in the first place and continue to fund it, be it the church or the government. Change has to take place through negotiation of power and interests. Finally, I became convinced that university faculties are very difficult to change--almost impossible. Although these experiences have not substantially changed my teaching perspectives (which were assessed prior to this experience), they have subtly influenced me to become more aware of accountability issues in teaching and learning. For example, I still hold a strong apprenticeship perspective on teaching; but now, I am also concerned with designing the details of a Work-Based Education Contract to formalize apprenticeship relationships and to satisfy accreditation criteria. I am still no fan of lecturing, but I began to spend more time preparing and pre-recording MP3 lectures for students who need to read and listen in order to learn.

4.8.2 Conflicting Worldviews

Perhaps my deepest reservation concerning constructivism relates to my differences in worldviews with Piaget, Vygotsky, and Dewey. According to Nash (1992), "a worldview, then, is a conceptual scheme by which we consciously or unconsciously place or fit

everything we believe and by which we interpret and judge reality" (p. 16). Although it is not necessary to declare one's worldview in scholarship but as a practitioner-researcher, it is helpful for me to understand how one's worldview could bias one's ideas. First, I identify my own worldview with those of a Christian theist. Although Christians hold different interpretations of Scripture, the Apostles' Creed has articulated the common Christian beliefs succinctly for more than 2000 years. It is at some (not all) of these core beliefs that I differ from the foundational theorists of constructivism.

As Egan (2002) has pointed out repeatedly, Piaget and Dewey's progressivism is rooted in the Darwinian theory of evolution which "linked animals and human in a single conceptual system regulated by natural laws" (Vygotsky, 1978, p. 3). This is in conflict with my own belief that human beings are unique and, along with "heaven and earth," were created as a direct act of God.

Vygotsky (1978), on the other hand, held to a belief that human intelligence is unique and complex and cannot be decomposed into simpler elements of animal behavior. However, Vygotsky is a materialist. He "and his colleagues sought to develop a Marxist theory of intellectual functioning" (Vygotsky, 1978, p. 1). Marxists view social progress as a sole function of human agency--in terms of the <u>actor</u> and <u>acting</u>. Popkewitz (1999) wrote the following:

The construction of the actor was a radical epistemological move as historical practices were freed from the direction of eternal, transcendental forces. If things had a hidden order that could be methodologically explored, then the past, the present, and the future could be seen in a seamless temporal pattern that could be administered and, in some cases, given direction. (p. 25)

This view, again, is in conflict with my own worldview. As a Christian educator, I believe that human beings have responsibility to God, their creator. But God is ultimately the God of history who can and does intervene into his creation. God has especially intervened in the redemption of humankind through the work of Jesus Christ. Thus, it is inadequate to explain history or change destiny solely by human actions since the most powerful transformation any human being could experience, in the Christian worldview, is the divine act of redemption. That is why we have prayers in schools to petition divine intervention in the educational process.

4.9 Summary

In this chapter, I traced some of the significant events that have formed my dominant and recessive teaching perspectives. These perspectives and assumptions are integral to the constructivist framework advanced in the next chapter. Looking back, I can see how early failure in the school world had taken me on a quest for learning in the work world and how success in the work world had taken me back to change the school world. Given the scope of this thesis, I also have not elaborated on how my university experiences in North America at UBC, GWU, and BJU have strongly influenced my backup teaching perspectives. The notion of a developing and nurturing relationship between teacher and students and the vocation and mission of a Christian teacher are central to my ethos as a university teacher today. In terms of how theory interacted with practice in my career as an IT professional and educator, I can see four distinct milestones:

1. Practice without theory stage (pre-1994): During this time, I dove into whatever work needed to be done, learning from the raw experience itself.

- Reflecting practice from theory (from 1994): During my study at GWU, I began to reflect on past and current practices and tried to make sense of various kinds of educational and social science theories. At UBC, I was exposed to more educational theories but from a more critical perspective.
- 3. Practicing with theory (from 1996): Beginning at ITI, I intentionally brought constructivist educational theories into my practice and found them effective in postgraduate, undergraduate, and CPE contexts.

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 Theorizing practice (from 1998): The EdD thesis led me to embark on formalizing the Principles for Authentic IT Education.

These principles are presented in the next chapter as a constructivist framework to guide the practice of adult IT education.

5 Principles for authentic IT education

I titled this thesis <u>In Search of a Constructivist Paradigm to Guide the Practice of</u> <u>Adult IT Education</u>. This search took me through years of research and reflection on literature, current practices, and personal experience. My purpose is to develop a set of principles that practicing teachers can easily understand and apply in their day-to-day work. The search culminated in this chapter with the Principles for Authentic IT Education.

5.1 Overview

These principles are designed for teachers and decision-makers with little formal pedagogical training or tolerance for theories. These principles were purposely kept simple. The complicated ideas of constructivism and all other theories had to be greatly simplified and reduced to a few powerful words or thoughts. I encapsulated the key ideas of pedagogical constructivism into the word "authenticity" and let the word carry the message. Furthermore, these principles are inclusive. They are not a rigid set of guidelines or an instructional design method. Anyone who reads this, whatever perspective s/he teaches from, should be able to say, "I think I could use some of this in my practice right now!" Therefore, I have made extensive use of "reflective questions," rather than prescriptive statements, to elaborate on each principle. The Principles of Authentic IT Education apply to IT education in the real world, by the real world, and <u>for</u> the real world.

5.2 First Principle–In the Real World

IT education in the real world means working with the environment and in the context of the real world. This principle advocates using the environmental pressure inherent in the real world of IT practice to energize the learner's natural cognitive adaptation capability.

This will lead educators to organize learning experiences around real world work functions rather than around bodies of knowledge.

5.2.1 Theoretical Basis

This principle of using the environment to energize learning is rooted in Piaget's (1968) theory of <u>genetic epistemology</u>. Piaget approached human knowledge from a biological standpoint and viewed learning as a process of <u>adaptation</u> to the environment. The human mind, like the human body, is designed to adapt on two levels. The first level is the practical need to fit and survive constraints in the environment. The second level is to achieve a mental balance and to avoid internal contradictions. Thus, learning (structuring of reality) is first in our genes before it is in our schools (von Glaserfeld, 1997).

The principle of organizing the learning curriculum around real work is rooted in John Dewey's progressive education philosophy (Berryman & Bailey, 1992). Dewey believed that schools must be an authentic microcosm of community life where common experience is socially negotiated involving intercourse, communication, and cooperation (Dewey, 1916).

While the environment cannot be controlled, educationalists believe that learning can be <u>situated</u> (Lave, 1988). In IT education, to <u>situate</u> learning means to create the conditions in which students will experience the complexity and ambiguity of learning in the real world of IT, rather than in the academic world of the school. Students will construct their own knowledge out of the raw materials of experience, i.e., working with clients, team members, a mix of technologies, business processes, etc. Brown, Collins, and Duguid (1989), among others, developed <u>cognitive apprenticeship</u> as an instructional model to operationalize <u>situated learning</u>. This model addresses four aspects of learning:

- 1) Content should include both domain knowledge and strategic knowledge.
- Teaching methods should be designed to give students the chance to observe, engage in, invent, or discover expert strategies in an authentic context.
- 3) Sequencing should be problem-based, which features increasing complexity, increasing diversity, and developing global before local skills.
- The learning environment should reproduce the technological, social, motivational, and frustrating characteristics of the real-world situations where learning is applied.

5.2.2 Implications for IT Education

The environment, properly utilized, can stimulate the practitioner to new ways of viewing the IT learner and the instructional process. There is already a huge environmental pressure for practically every mind to survive technological disruptions to life. For example, a person needs to get or keep a job, get money out of the bank, send a child's picture to a distant grandmother: technology stands in the way of everything.

Because knowledge construction is viewed as a personal process, this concept also encourages ownership of the process and product of learning. Learners are no longer passive receivers of canned knowledge. Rather, creative people who believed in their own construction of meaning redefined the world for us through innovative products.

Academe generally situates learning in a school context. This context enforces certain norms or practices for all programs. Authentic IT education, on the other hand, is situated in a professional work context. There are fundamental differences between these two situations in how IT education approaches learning content, method, sequencing and sociology. These differences are summarized in Table 1.

Table 1

School-situated Learning vs. Work-situated Learning

	School-situated Learning	Work-situated Learning
Content	Learning scoped by a curriculum	Scoped by work to be done, e.g., develop
	authority, e.g., ACM, IEEE,	and deploy an e-Commerce application for
•	Microsoft, IBM, Cisco, etc.	XYZ Toy Company; port a system from
		Windows to Linux; administer a Novell
		network; support a help line
	Knowledge compartmentalized	Integrated by work to be done, e.g., to port
	by subjects like accounting,	an application, you have to know
	project management, database,	something about operating systems,
	operating systems, and data	programming, database, accounting,
	structures	project management, all at the same time –
		enough to solve the problem at hand.
	Well-defined problems with	Ill-defined, messy problems like those
	learning objectives clearly stated	found in the real world
	and measurable	
	Knowledge often taken out of	Knowledge kept alive informally by a
	practice context and generalized	community of practitioners, e.g., system
	as "best practices" or theories	administrators share information on
		fighting computer virus
Method	Knowledge communicated by	Knowledge constructed individually and
	lectures, books, CBT, courseware	corporally by doing real work, by
	and other media	interaction with other learners and experts,
		by discovery and research required to
		solve problems
	Evaluation by exams, tests, and	Evaluation mostly implicit in the work
	papers	itself. If the system malfunctions or
		crashes, then it obviously failed.
Sequencing	By logical decomposition of	Sequenced by the problem or work at hand
	subject matter, e.g., by the table	
	of contents in a textbook	
	Staged by prerequisite knowledge	Staged by increasing complexity and
	and prior learning	variety, e.g., <u>use</u> an ERP system, <u>maintain</u>
		an ERP system, <u>design</u> an ERP system,
		<u>integrate</u> an ERP system with a CRM
		system
Sociology	Academic community like	Project teams that form and dissolve
	schools departments, and classes	according to work needs. Connected to
	connected by a system of peer-	other practitioners by BBS, forums, trade
	review, journals, conferences,	publications and shows, user groups, and
	listservs, etc.	so on.

5.2.3 Examples from Practice

How can the motivating force of the environment and the authenticity of the workplace be utilized to create learning experience "<u>in</u> the real world?"

5.2.4 Building a Technical Portfolio

At ITI in Canada, grades were not the primary motivator; the job offer was. During the yearlong program, each student created a technical portfolio. The portfolio documented IT projects s/he had done using Visual Basic, Java, Oracle, DB2, deployed on both desktop and enterprise architectures. The portfolio contained design documents as well as program codes, user interfaces, data dictionaries, etc. The portfolio, then, became the conversation piece in a job interview which, in turn, resulted in job offers.

5.2.5 e-Business Course with a Job Search Theme

The dream of many students at the Chongqing Institute of Technology in China is to find a job with a multinational corporation. The e-business course I teach at CQIT uses job search as a theme to learn about e-business. Students study career advertisements from ebusiness companies to understand what e-business jobs are all about. They learn to use various search engines to find job opportunities, understand job requirements, submit electronic resumes, and market themselves through their own websites.

5.2.6 Environmentally Sensitive Instructional Design Process

ITI strategically situated its curriculum in the e-business consulting context. To design learning experiences for that context, ITI instructional designers did the following:

 Studied and analyzed thousands of recruitment ads from employers, especially outsourcing and consulting companies with an e-business practice.

- 2) Engaged several leading consulting companies to work with ITI in a needs analysis process. Rather than describing what an entry-level consultant needs to know and do, I asked them to tell me stories about successful entry-level recruits as well as cases of failure. Through an inductive process, we then arrived at the desirable and undesirable qualities in an entry-level consultant.
- 3) Even though this knowledge was extracted from practice, we did not teach them apart from their context, i.e., we did not create lesson plans around the subject matter itself.
- 4) Instead, we engaged the same consulting companies to create a series of authentic e-business projects that will synthesize as many of those objectives as possible. In other words, when the student completes the project successfully, s/he will have achieved the desired learning objectives. The evaluation is implicit in the work itself. The scope and sequence of learning are then controlled by these projects and not by subject matter.
- 5) Once the e-business projects were accepted, the consulting companies were engaged in the instructional development process. ITI instructors worked on the projects first, coached by the consultants, before facilitating the students through those same projects.

5.2.7 Questions of Environment and Context

 How do you help learners to <u>assimilate</u> and <u>accommodate</u> real world IT technologies into their lives? How comfortable are they with the latest IT gadgets and services?

- 2. How do you use the survival instinct of the learner (the need to find or keep a job) in your instructional strategy?
- 3. How can you capture the "thirst for knowledge" from learners to power the learning process?
- 4. How necessary are the pre-requisites in your program? If these subjects are now entry barriers to your program, whom do they intend to exclude?
- 5. How do you make your subject matter relevant to each learner? Do you leave it up to him or her to connect the subject taught to his or her reality?
- 6. How do you engage the learner to take ownership and responsibility of the process and product of learning?
- 7. Globalization is moving many IT jobs from the developed world to the developing world today. Is your program attuned to the threats and opportunities that this change will bring, or are you still operating "business as usual"?
- 8. How are students motivated <u>intrinsically</u> to learn? For example, does the curriculum allow the student to work on problems relevant and useful to himself or herself?
- 9. Are learning materials highly componentized and decontextualized? For example when you teach an algorithm, do you care what technical platform (enterprise, desktop, mobile, etc.) this algorithm is implemented on?
- 10. How do you develop the student's ability to transfer smoothly from school to work?
- 11. Are you actively trying to model your training program after the workplace?

- 12. Do your students experience the complexity and ambiguity of real world IT in their learning process? Are they learning from ill-structured, real-world problems or sanitized textbook cases?
- 13. How connected is your learning community with the real world communities of IT practice? For example, do you participate in industry (not just academic) conferences, trade shows, etc.? Are your students wired into practitioners' online communities?
- 14. To what extent are you separating <u>work</u> from <u>learning</u>? To what extent are you able to extract learning opportunities out of day-to-day work and make that the driving force of learning?
- 15. Is the sequence of learning <u>subject-based</u> or <u>problem-based</u>? Do you let the textbook handle your sequencing?
- 16. As an outcome of your course or program, is the learner better equipped to <u>do</u> IT or just <u>talk about</u> IT? Does your pedagogy involve mostly doing or mostly lecturing?
- 17. Are the standards of performance and evaluation of competence implicit in some real world learning activity, e.g., efficiently working codes rather than correct answers?
- 18. Does the curriculum address both <u>domain</u> and <u>strategic</u> knowledge, e.g., Java programming studied apart from the operating systems or architectural contexts?
- 19. Does the curriculum address both <u>explicit</u> and <u>tacit</u> knowledge? Where is the <u>tacit</u> knowledge coming from?

- 20. Are sufficient modeling (of artifacts and people) opportunities designed into the curriculum? For example, has a student used, dissected, and analyzed a number of good and bad real world Java programs before developing his or her own?
- 21. In longer courses and degree programs, are scaffolding and fading designed into the program to ease the learner's transition from school to work?
- 22. Is knowledge mostly transmitted through <u>abstraction</u> or decontextualized theories rather than <u>narratives</u> or "war stories?"
- 23. Is the learning environment safe (supports error recovery, etc.)?
- 24. Is the learning environment friendly (maximum user control, emotional support)?
- 25. Does the learning environment allow freedom to explore?

5.3 Second Principle--By the Real World

The second principle concerns authentic mediation--real tools and real people mediate real learning. This principle posits that effective, professional IT education is mediated by using real world tools, delivering useful and realistic products, and socializing into a community of practitioners. It does not "dumb down" or sanitize real world objects for the classroom, if at all possible. It assumes that a learner is better off somewhat confused in the real world than totally clear in a logically constructed but unrealistic world.

5.3.1 Theoretical Basis

Vygotsky (1978) emphasized the importance of <u>cultural mediation</u>, i.e., the mediation of <u>artifacts</u> and the mediation of <u>other people</u> in human learning. According to Vygotsky, the human mind consists of more than just the grey matter between our ears; it is extended into

and intertwined with all the stuff that we use and make and our communication with other people. Teaching, in order to be effective, has to be mediated by a rich environment of artifacts and people.

First, <u>artifacts</u> is used as a broader term to include (in the IT context) programming languages, operating systems, books, methodologies, magazines, websites, hardware, software, architectures, lingoes, games, toys, and so on. I call these "stuff." Our biological mind is fully intertwined with our stuff. Just think: how smart are we without our laptops and the World Wide Web? How <u>happy</u> will our children be apart from their GameBoys? How <u>lonely</u> will people become without their cell phones and email?

Second, Vygotsky believed that knowledge is first <u>socialized</u> before it is <u>internalized</u> in people. For example, Joe has absolutely no idea how to create web pages. He could not do it even if you held his hand and walked him through every step of the process. Then there is Jane, who can do it if Jack is around to remind her of how some HTML tags work. Of course, Jack can do most kinds of web pages without involving another person. If he forgets something, he looks it up in the manual or other web pages (artifacts) he has created before. Psychologists would say that Jane is learning in a "zone of proximal development" or ZPD. She has a <u>socialized</u> knowledge of HTML. How transformation occurs in the ZPD, or how Jane could move to Jack's level of competence, is of utmost interest to educators since schools and teachers mostly operate in the zone.

5.3.2 Implications for IT Education

In terms of IT education, we have to ask the question, "How do we <u>socialize</u> our students into the <u>culture</u> of IT?" Asking this kind of question will lead us to seek out instructional paradigms that will exploit a variety of useful artifacts or learning media. It is

not just a matter of bringing in all kinds of artifacts, but we shall seek a framework where these artifacts can transform mental functions in a fundamental way. Cultural mediation challenges IT teaching in a number of ways:

- <u>The "dumb down" syndrome</u> hides complexities of real world <u>architecture</u> from students. The use of extremely outdated hardware and software tools hinder the students' transition from school-to-work. We also dumb down when we let textbooks carry the weight of teaching.
- 2. <u>The "Mickey Mouse" assignment</u> asks students to do things that are neither useful nor relevant <u>to the student</u>, e.g., writing a calendar program when all kinds of calendar programs can be downloaded for free on the web. These assignments have no value beyond the course itself and cannot be used as a tool in subsequent learning activities.
- 3. <u>The "build everything" syndrome</u> is a "code everything from scratch" mentality, e.g., calendar, zip code checker, etc., instead of using existing artifacts like class libraries. This is not what happens in the real world. In fact, it is very useful to learn to assemble a solution (a new artifact) from components (existing artifacts).
- 4. <u>The "out-there" mentality</u> is being out of touch with employers of graduates, IT user communities, industry giants who set the technology pace (whether we like them or not), and so on. Remember, IT education is about socializing a learner into a community of practitioners. That cannot be done without somehow weaving the practitioners tightly into your program and curriculum.

- 5. The <u>"success stories only"</u> mentality ignores the fact that the real world of IT is full of failures. They make just as good (maybe even better) learning cases as the success stories. Ever invited an IT professional who has just been fired, or someone whose dot.com company just failed, or some executive who had to scrap a three-year SCM project to speak in the classroom? It may be an invaluable experience for your students.
- 6. The <u>"teacher must know everything"</u> mentality insists that a subject-matter expert is always needed or helpful when learning in the ZPD. However, anyone who knows something more (or different) than the learner could be a good learning partner. That is why collaborative learning, cooperative learning, and peer tutoring are such effective strategies in professional education. The teacher can best model what learning is all about when s/he facilitates the learning of an unfamiliar subject.

5.3.3 Examples from Practice

5.3.4 Cultural Mediation in Teachers' Professional Development

This in-service course brought together cohorts of 30 Hong Kong teacher leaders for four consecutive Saturdays. The purpose was to develop their abilities to integrate IT across the curriculum. The course covered some curriculum theories, which was the last thing exhausted teachers wanted to listen to on their precious Saturdays. So instead of lectures, the teachers worked in interdisciplinary teams of three to five. Each team constructed a product that was useful in their real world, e.g., lesson plans, courseware, and so on. A commentary accompanied the product to explain how the artifacts depicted their understanding and interpretation of various curriculum theories. Besides being a useful product to take back to

their own school, the project was shared with all other students on the Internet. Subsequent cohorts learn by studying the projects of previous cohorts, so cultural mediation actually happened from class to class.

5.3.5 Questions of Mediation

- 1. What kinds of artifacts mediate the learning process. i.e., books, gadgets, networks, software, AV, prototypes, toys, lingo, frameworks, or symbols?
- 2. Is learning mediated by anyone other than the instructor and the students? Do you involve IT practitioners, researchers, users, and businesses in the learning process?
- Does your instructional process recognize a <u>zone of proximal development</u> or <u>ZPD</u>? Specifically, how do you respond to learners with varying levels of mastery?
- 4. How do you involve learners helping other learners towards the learning objectives?
- 5. Does your course involve the production of an <u>authentic</u> artifact that may be used as a tool in a subsequent learning activity?
- 6. If you ask the learners to work collaboratively on an IT project, is effective teamwork skills development an explicit objective in your course? In other words, how do you develop the "soft skills," or are you leaving these up to the students to figure out?
- 7. Do you have a framework that could bring into the learning process various real world artifacts in a way that could fundamentally transform the students' thinking process?

- 8. Do the learners have opportunities to learn from <u>master practitioners</u> of IT, or are they learning mostly from non-practitioners? How is on-the-job training integrated into your learning program? Do master practitioners coach them?
- 9. How are students encouraged to articulate and share their learning experiences with each other?
- 10. Does the sociological environment provide the student with multiple representations of knowledge from different sources and individuals?
- 11. What kind of legitimate peripheral participation do the students engage in, e.g., user groups, co-op work terms, local CIPS chapter, etc.?

5.4 Third Principle--For the Real World

The third principle is the principle of authentic mission or purpose. This principle emphasizes the need to align IT educational goals with institutional missions and moral actions in order to change human society. IT is always a means and never an end in itself. Almost every university has in its mission statement a commitment to change human society. Supporting that mission statement and integrating it into educational outcomes is a matter of integrity. IT is not only about business but also about illiteracy, hunger, disease, oppression, poverty, injustice, and a host of other human miseries.

5.4.1 Theoretical Basis

In his argument against dualism, Dewey (1916) maintained that a vital connection between occupational knowledge and moral action is important in education. Curriculums are "organs of initiation into social values" (Dewey, 1916, \P 3) by virtue of what they promote and what they exclude. Like Dewey, Paulo Freire (1997) opposed dualism. He saw "that a revolution is achieved with neither verbalism nor activism, but rather with <u>praxis</u>" (p. 107),

that is <u>reflection</u> and <u>action</u> directed at structures to be transformed. Liberatory pedagogy supports this notion of continuously re-inventing of society as an essential human function.

5.4.2 Implications for IT Education

If IT education is the solution, then what is the problem? Today, university IT programs are quickly working themselves out of a job. NCES figures tell us that IS (Information Systems) enrollment growth lags behind most other disciplines like biological sciences, philosophy, and so on. Even performing arts graduates outnumber IS graduates by more than 20,000 each year. By narrowly defining what IS study is all about, IS programs paint a stereotype of the IS professional that discourages a broader spectrum of young people from considering this career path. In reality, IT is the single most powerful force of change in society today. The proliferation of IT in the workplace and into everyday life has resulted in health problems, socio-economic problems, and geopolitical problems. Many organizations are trying to solve these technology-induced problems. They could be churches, labor unions, mental health associations, small business associations, and so on. Their voice can inform curriculum designers of a much richer meaning of the term "solving real world problems." To be socially relevant, a university has to develop leaders who can build a different world. It will lead us to look at "official curriculum" more critically. It will prompt us to ask the question, "Whose interests do they serve?"

5.4.3 Examples from the IT World

When UN Secretary-General Kofi Annan said at the Networld Order Conference that the IT industry has a responsibility to bridge the "digital divide," he was challenging IT educators to live up to the responsibility of global citizenship. Although IT schools are not generally perceived as hotbeds for social activism, some individual professionals and IT

companies prefer to change the world quietly, away from the limelight. For example, the Bill and Melinda Gates Foundation spends over \$6 billion each year to address inequities in health and education, at home and abroad. Also, HP's Digital Garage project in Sao Paulo, Brazil, is designed to bring underprivileged youth into the digital economy. It combines technology and music to help them develop job skills and better life perspectives.

5.4.4 Questions of Mission

- 1. How do your program plan and course syllabi reflect the mission statement of your institute?
- 2. Is the goal of your program just to prepare well-trained, compliant workers for an efficient society, or are you also developing change-adaptable and change-leading persons in a complex global and technological society?
- 3. Is our kind of IT education changing human society into a better or worse place?
- 4. How are you actively closing the "digital divide"?
- 5. Have you ever critically examined the official curriculum? Whose interests does it serve? Or are you taking it as something given?
- 6. Does your department cooperate with schools in the developing world?
- 7. Do your faculties have the opportunity to teach in third-world programs?

5.5 Summary

This chapter is the most significant part of this thesis as it is the result of the quest for a constructivist paradigm to guide adult IT education. These principles are significant in at least three respects. First, they are simple to explain: education <u>in</u>, <u>by</u>, and <u>for</u> the real world. Second, they have broad theoretical underpinnings to support rich pedagogical constructions. Finally, they are practitioner-oriented. It has proven, at least in my own

experience, to be an effective framework for experienced professionals moving between the world of practice and university teaching. Whether they could be equally usable for the university teacher is the subject of the next chapter.

6 FOCUS GROUP REPORT

6.1 Background

This chapter explains the focus group methodology used as well as reports and interprets the focus group findings. Let me first review how the focus group exercise fit into the overall investigation. The purpose of this study is to develop and evaluate a set of constructivist principles to guide adult IT education, especially in the university context. This study began with a search of constructivism literature for pedagogical insights. That was followed by a review of dominant IT educational practices to identify possible improvements. Through a reflective process, theory, practice, and personal experience were synthesized into the Principles for Authentic IT Education. My first experience with constructivist IT education was at ITI, a private Canadian training institute. However, my goal was to implement these principles in American university-based IT programs. Thus, there was a need to investigate how receptive American educators would be towards this new paradigm. The focus group methodology used is consistent with The Focus Group Kit by Morgan and Krueger (1998). The findings reported in this chapter informed the conclusion and recommendations in the final chapter of this study. Each group was first given a scripted PowerPoint presentation on the essence of authentic IT education before being asked the questions in the following section.

6.2 Focus Group Methodology

The purpose of the focus groups was to perform a formative evaluation on the Principles for Authentic IT Education developed in this chapter. The objectives were to (a) ascertain the need for a constructivist approach to IT education, (b) gather insights into the level of acceptance of a constructivist approach among university teachers, IT professionals

and curriculum planners, (c) understand practical issues and difficulties involved in implementing the principles within a university environment, and (d) recommend practical implementation advice on adopting these principles. The focus group methodology used in this study is consistent with the comprehensive guide in the six-volume <u>The Focus Group Kit</u> by Morgan and Krueger (1998).

6.2.1 The Suitability of Focus Group Method

The framework proposed in this chapter is radically different from current collegebased IT educational practices reviewed in chapter 3. For example, the ACM Body of Knowledge that is neatly divided into silos of courses now will be "scrambled up" in an authentic approach to learning. Instructors who are used to teaching one or two IT subjects will have to function beyond their normal skill and knowledge domain. Program administrators will be challenged by the integration of practicing IT professionals into the learning community as adjunct faculties. The use of real world documents instead of textbooks will challenge curriculum developers. Altogether, the implementation of these principles represents a paradigm shift for IT educators. A successful implementation will require IT educators to be aware of the potential responses from stakeholders, particularly teachers.

According to Morgan and Krueger (1998), the four basic uses of focus groups are for (a) problem identification, (b) planning, (c) implementation, and (d) assessment. A successful implementation of the framework will require more than theories from literature or personal experience. It will require insights and information into perceptions of users, potential problems, risks, and so on. The focus group method will allow the kind of guided discussions where rich information on IT educators' feeling can be gathered.

6.2.2 Focus Group Planning

Morgan and Krueger (1998) identified a number of key decisions to be made at the focus group planning phase. They pertain to (a) degree of structure, (b) group composition, (c) group size, and (d) number of groups.

Since the kind of constructivist IT educational principles proposed in this study are, to my knowledge, not used in university programs, my overarching goal in the focus group was to explore the "what ifs" of such an implementation. For this kind of exploratory investigation, Morgan and Krueger suggest a less structured approach that can provide insights into a range of issues that need to be understood. This level of structure influences how questions are formulated as well as the style of moderation.

Several factors influenced the composition of the focus groups. Unlike survey-type studies where random sampling is used, focus groups require <u>purposive sampling</u>. Morgan and Krueger (1998) explained:

The reason for this divergence is the fundamental difference between the goals of focus groups and the goals of survey. The goal in surveys is to generalize to larger populations by collecting numerically precise data, and this requires selecting a random sample that will cover the entire range of the larger population. The goal in focus groups is to gain insight and understanding by hearing from people in depth, and this requires selecting a purposive sample that will generate the most productive discussions in the focus groups. (Vol. 2, p. 56)

Consistent with the strategy of purposive sampling, I decided on a group composition that will best serve the purpose of my study. First, I am a teacher and instructional design

consultant for three Midwestern American universities, and my goal is to implement these principles in an American university program. Therefore, I wanted to hear from frontline teachers and instructional designers of similar universities. Secondly, Midwestern universities are accredited by the North Central Association of Colleges and Schools (NCA), and curriculum changes have to meet the NCA standards. Thus, participants will need some familiarity with the NCA accreditation process and criteria. Finally, I had less than half an hour to describe what constructivist IT education would look like; the teachers and instructional designers should have some exposure to constructivist methods, such as problem-based learning or collaborative learning.

In order to generate productive and free-flowing conversation, <u>homogeneity</u> and <u>segmentation</u> are also critical factors of successful focus groups (Morgan & Krueger, 1998). I conducted three focus groups in two cities. The groups are more or less segmented by their IT educational roles of teachers, IT professionals, and instructional designers.

Several factors influenced the group size and the number of groups. Morgan found that typical focus group size is six to ten. Given that most focus groups last only 90 minutes, the size has direct bearing on how many questions can be asked. Since achieving depth of understanding was my goal, I intended to have smaller groups and deeper conversations. While the fact that participants in each group are acquaintances, Morgan suggests that this is not necessarily a disadvantage as the focus group was about a hypothetical learning approach and did not involve any confidential information. The decision on the number of groups was primarily influenced by time and budgetary constraints: I had a week to travel from Hong Kong to Minot, North Dakota, as well as Denver, Colorado, for this exercise.

The first two focus groups were organized by my former colleague at the University of Dubuque, Rod Hewlett. The groups met at Minot State University (MSU) on 13 February 2004. The third group was organized by my former colleague at ITI, Judith Murray. This group met in Regis University's New Ventures office in Denver, Colorado, on 16 February 2004. The composition of each focus group was as follows:

6.2.3 Minot Focus Group 1 (IT Teachers)

The first group was predominantly frontline IT teachers. Of the six members, only one was an IT professional. The five teachers from MSU averaged 18 years of college teaching experience. They teach undergraduate courses in computer application, database design, systems analysis, and web development. Since MSU was previously a "teachers" training only" college, most of these teachers were familiar with the application of constructivist theories in the primary and secondary education and did not require an extensive explanation of what is pedagogical constructivism. The group included five females and one male.

6.2.4 Minot Focus Group 2 (IT Professionals)

The second group was mostly IT professionals. Of the five members, only two are teachers from MSU, including the head of the Business IT program. The other three included the CEO of a computer-consulting firm, an IT customer engineer working at a national call centre, and a data processing manager from a major airline. These practitioners all serve on a curriculum advisory committee for MSU's IT and Business programs. One has served as an adjunct faculty in the business school as well. Although the IT professionals did not have the knowledge of learning theories, they were well-acquainted with "learning by doing" and "learning in the real world" since they have integrated this kind of learning into their daily

lives. As employers of MSU graduates and curriculum advisory board members, they were familiar with IT educational issues found in a university context and could offer valuable insights from those perspectives. This group was composed of three males and two females.

6.2.5 Regis Focus Group (Instructional Designers)

The Regis focus group had five instructional designers, an IT supervisor, and a teacher. Regis New Ventures is an arm of Regis University involved in the development and sale of business and IT curriculum used by over 20 other universities in adult accelerated degree completion programs. Students who attend these accelerated degree completion programs are usually older working adults with an average age of 37. Besides being experienced teachers, the curriculum developers in this group are well-versed in adult learning theories. One of the five curriculum developers is an ex-colleague from ITI. The group included four males and three females.

While I am satisfied with the overall composition and size of these three groups, potential concerns must be addressed. Some readers may be concerned with the fact that 18 participants do not represent the population of IT educators in college programs. However, focus groups are not designed to collect generalizable data as in random sampling. The <u>purposive sampling</u> strategy used by focus groups is designed to produce understanding and insight through a process of free-flowing conversation. My relationship as external consultant to Regis and adjunct professor at Minot may also raise concern about my objectivity as a researcher and moderator. First of all, since I lived in Hong Kong, I did not work directly with any of the participants in the focus groups. I taught my courses online, and I prepared consultant's studies online for both universities. Therefore, except for one ex-colleague from ITI, I met all the participants for the first time at the focus group. The basic question is not

how well I am acquainted with the participants but "whether the participants will feel comfortable discussing the topic, not only among themselves but with this moderator" (Morgan & Krueger, 1998, Vol. 2, p. 69)? That all important criterion was met in this study.

6.3 Developing Questions for Focus Groups

Morgan and Krueger (1998) described two questioning strategies commonly used in focus groups--the <u>topic guide</u> and the <u>questioning route</u>:

The topic guide is a list of topics or issues to be pursued in the focus group. This list consists of words or phrases that remind the moderator of the topic of interest. By contrast, the questioning route is a sequence of questions in complete, conversational sentences. (Vol. 3, p. 9)

This study took the questioning route in order to achieve greater consistency and efficiency of analysis. The questions developed for the focus groups were adapted from the five categories suggested by Morgan and Krueger: (a) opening question, (b) introductory questions, (c) transition questions, (d) key questions, and (e) ending questions.

6.3.1 **Opening Question**

The focus group began with each participant introducing himself or herself to me (they mostly know each other): their names, their roles in the institution, and the number of years they have been teaching. These questions are factual rather than attitudinal and, according to Martin and Krueger, are typically not analyzed.

6.3.2 Introductory and Transition Questions

Morgan and Krueger (1998) described introductory questions as those questions that introduce the general topic of discussion and/or provide participants with an opportunity to reflect on experiences and their connection with the overall topic. The questions foster conversation and interaction but are not critical to

analysis....Transition questions move the conversation toward the key questions that drive the study. (Vol. 3, p. 24-25)

These questions followed immediately after a presentation of the constructivist IT educational features (Appendix A): (a) What is the first thing that comes to your mind? (b) Is there a need for this kind of paradigm shift in IT education today? (c) Do you think it will enhance or reduce the quality of IT education?

These questions served two purposes. First, they helped me gauge the level of understanding the participants had about constructivist educational practices. Secondly, I wanted to know whether their first impression of a constructivist approach to IT education was positive or negative <u>before</u> exploring the various problems that could rise from its implementation.

6.3.3 Key Questions

"The key questions drive the study" (Morgan & Krueger, 1998, vol. 3, p. 25). My first implementation of constructivist IT education was in the ITI schools, a private, forprofit, training corporation context. Within that context, schools have a much greater degree of curriculum flexibility since they do not have to deal with regional accreditation, faculty unions, and a host of other issues. I wanted these questions to shed light on the range of responses and difficulties that an implementation of the framework could bring to students, employers, and faculty members, especially in a typical Midwestern university context. As my goal was to stimulate a deep conversation, I limited the number of key questions to four open-ended ones: (a) How do you feel students will respond to this way of learning? Will they resist or embrace this shift, and why? (b) How do you feel faculty will respond to this

shift – resist, embrace, why? (c) What are the advantages and disadvantages of hiring a graduate trained the constructivist way compared to the traditional way? (d) What are the difficulties you see in implementing this type of IT program?

6.3.4 Ending Question

According to Morgan & Krueger (1998), ending questions "bring closure to the discussion, enable participants to reflect on previous comments, and are critical to analysis" (Vol 3, p. 26). After describing the range of problem this framework can bring, I wanted to hear about the range of solutions. Thus, I asked, "What will it take to make such a model work?"

6.4 **Processing Focus Group Data**

Morgan and Krueger (1998) found that "systematic analysis procedures help ensure that results will be as authentic as possible" (Vol. 6, p. 10). This study followed several recommendations made by Morgan and Krueger to ensure systematic processing of interview data. These included proper sequencing of questions, systematic processing of capturing and handling data, and axial coding of data. Specifically, the steps of data gathering and processing were (a) taping (each session was tape-recorded using a portable Sony M-100MC recorder), (b) transcribing (each tape was then transcribed to text), (c) sorting (the answers from each focus group were sorted and re-organized by each of the five questions asked), (d) coding (the answers were then color-coded based on whether the comment expressed was positive, negative, or a suggestion for improvement), (d) analyzing (repetitive opinions, ideas, or feelings were identified; differences between focus groups were compared and contrasted), and (e) reporting (the findings to each question were then reported in the next section).

6.5 Summary and Limitations of Study Approach

This study followed a method that involved six discrete tasks: (a) constructivist literature review, (b) IT educational practice review, (c) autobiographical reflection, (d) principles development, (e) focus groups review of principles, and (f) recommendations to IT educators.

Since this study used a mode of inquiry associated more with educational practitioners than the typical empirical mode used by educational researchers, readers could have potential concerns regarding the validity of this study or the generalizability of its findings. These concerns usually stem from a misunderstanding of the goals of qualitative research in general and focus group research in particular. As Morgan and Krueger (1998) explain,

In the positivistic or quantitative tradition, it has been important to determine validity, because a test or instrument was created to measure something, and it would occasionally measure the wrong thing....By contrast, in focus group research, there are no proxies. The actual words of participants, not instruments are used to find out their feelings, thoughts, or observations about a topic of discussion. (Vol. 6, p. 68)

The purpose of this study was to gain insight and understanding into the practice of adult IT education and not to generalize. Even so, it does not mean that the principles and findings of this study cannot be <u>transferred</u> into another environment. Morgan and Krueger explained the concept of transferability as follows:
A person who wants to use the results should give thought about whether or not the findings can transfer into another environment. The decision is made by examining the research methods, the audience, and the context and by considering if these situations and conditions are sufficiently similar to the new environment. (Vol. 6, p. 70)

In the end, this methodology served the purpose of this study by providing practical answers to the research questions. It is compatible with the EdD program principles of studying practice to improve practice.

6.6 Findings

6.6.1 Question: What Are the First Things that Come to Your Mind?

The first question is transitional and solicited participants' comprehension of the key attributes of constructivist IT education. Academic participants have some understanding of constructivism or, at least, some of the methodologies based on constructivism, such as problem-based learning, collaborative learning, experiential learning, and adult education. Understanding came from personal experience with using these methods as well as from a K-12 context. IT industry participants without a background in education associate constructivism with the authentic or real world aspects of this learning method. Participants confirmed unequivocally the need for a paradigm shift from the traditional subject-based, lecture-lab learning format to some kind of constructivist pedagogy. However, most saw major hurdles and difficulties in implementing this much-needed change. For example, participants made these comments:

Yes, I think there's a need and I think it will enhance the quality of IT education. My first impression is accreditation, assessment, integrating with other departments, the collaboration that needs to take place between business people and educators. So, love the idea, except the hurdles. (Female teacher) I've been interested in that for 40 years; but I've never seen it done in a holistic approach. (Male teacher)

It has a lot to do with the accrediting body and the way faculties have been hired and this whole subject-driven learning approach versus the horizontal approach. I think that structural things are one of the first things that need attending to. I absolutely think that it will enhance not just IT education, but all education. (Female curriculum developer)

6.6.2 Question: How Do You Feel Students Will Respond to this Way of Learning?

This key question focused on the participants' perception of the students' response--whether students will resist or embrace this type of learning and why. Most teachers have tried some form of constructivist pedagogy in their classrooms. Their feedback was informed primarily from those experiences. However, their past forays into constructivist teaching were quite different from the proposed framework since there was no structural change in the curriculum, such as the horizontal integration of knowledge across different subjects. In their experience, everything had to work within the traditional framework of subjects, courses, class hours, assessment, and so on. Typical comments included these:

I do that. 50% like it at the start. 50% try to hang out within their group to try to get a feel of what is going on, waiting for me to provide the solution for them. But halfway

through the course, they caught on what is going on and work along with their group. (Female teacher)

In a Database course where I tried to do this, 70% resisted and 30% get right

into doing it. I worked with them to get them there. (Female teacher)

Those who have tried some type of constructivist approach found, almost invariably, a pattern of student behavior consistent with my experience at ITI. At the beginning, students take a "wait and see" attitude, as this form of learning is different from their past educational experience and expectation. Then, as actual projects have to be delivered and serious work begins, strong resistance takes place. As they experience some measure of success, they begin to embrace this approach. At the end of the course, they do not want to go back to the traditional lecture-lab methods predominant in IT education today. Consistent with the finding of Luterbach (1997), participants found that students manage this kind of learning better if they are given a big picture initially and when expectations for the learner are set at the beginning. For example, participants commented,

I think they will like that kind of approach but not all of them can handle it. I think they will need a certain amount of basic information. I like to use the phrase 'transfer of learning.' I think transfer of learning is not often for the most part picked up by the average person and implemented. Most of the time transfer of that base learning needs to be taught so that some one will learn it and try to apply it and use it here. (Male teacher)

I think that from my context they'll embrace it. They'll also reject or resist it when it comes time for actual work. And they'll ask what's Step One and Step Two. So I'm there to show them a framework and help them to apply concepts so that they can construct their own mental model of good knowledge and to find their own mental model so they can apply to whatever their situation is. (Female teacher)

Students are motivated by success, teamwork, camaraderie ("party atmosphere"), and relevance to the real world. For example, one male teacher commented, "There is the fun factor. If you can make it fun, they want to come to class...if they are doing stuff that is cool, they're going to respond. If not, they won't do it."

6.6.3 Question: How Do You Feel Faculties Will Respond to this Shift?

This key question turned the spotlight on the perceived responses from teachers. How do focus group members feel fellow faculty members will respond to this shift? Will they resist or embrace it, and why? I expected a mixture of responses, somewhat like the ways in which students respond. But to my surprise, I found the members were almost universally pessimistic about the chances of faculty embracing such a paradigm shift. Participants felt that "this will be a tough sell" and "there are a lot of people who don't like to change and who may not be able to operate within this kind of structure."

You have the hurdle of selling the curriculum and you have got the hurdle of a whole different educational model. So I have to convince you that this is a right model. You're telling them that the model they're using is the wrong model. How would you say there is one right or wrong model? It's different strokes for different folks. So it kind of becomes the two hurdles in the sales process that you have to get through. (Female curriculum developer)

Resistance will be prevalent for a number of reasons, and most have nothing to do with the validity of constructivist pedagogy. For example, constructivism challenges tradition, people's comfort zone, and teacher's authority. Comments included the following:

There are a lot of people who don't like to change and who may not be able to operate within this kind of structure. That's not to say that there aren't anyone out there that you can find later. (Male curriculum developer) I think some faculty and some administrators suffer from a combination of fear and anger. Fear that education is changing under them, and anger because they have put a lot of their private energy in getting their advanced degree and now they see someone (adjuncts) coming in with their Masters – practitioners who will probably take their livelihood away from them. (Male curriculum developer)

Faculties are concerned about tenure, resources required, and their own perceived lack of confidence and overall readiness. One teacher felt that in order for a major paradigm shift in teaching to occur, faculties should have adequate support from an instructional development office or "teaching centre":

We just don't have the resources to support a teaching centre. (Male teacher)

One of the key issues is going to be money. As soon as they hear team teaching or sharing my courses and am I going to get the right load forever [Presumably, "right load" means no more teaching load than s/he is carrying right now.] (Female teacher)

Some faculties are concerned with the evaluation of teaching performance. They have been getting good performance evaluations under the traditional subject-centered method. Whenever they tried something out of the ordinary, students experienced anxiety, which affected their evaluations. For example, one said the following:

All those years we have been evaluated by students, when we're not following the textbook closely, I think I got lower evaluation. But if you follow the textbook step by step, and students know right where you are, I think they feel better. And I thought if I'll do it that way, then I know my students' evaluations will be better. (Male teacher)

Consistent with Pratt's (1998) concept on teaching perspectives, some are concerned that teachers have individual teaching styles that are hard to change. In order to make this paradigm work with teachers, focus group members felt that communicating expectations early on would be the key. In that way, schools could hire faculties to this pedagogical model like Regis University is doing today. Teaching evaluation, promotion, and money are then tied to success with this model. It also has to be a top-down push and an institutional commitment to change. Instructional issues such as teaching load must be settled up front and implemented in such a way that teachers will have "nothing to lose." Finally, support for technologies and processes must be in place. Focus group responses suggested various ways to make constructivism work for faculties:

You minimize resistance by setting expectation and hiring for a model. (Change) will have to come from the top and would have to be a university or school-wide long term plan. (Female teacher) I agree that there has to be institutional commitment. If not, it's very difficult to pull off the transformation. (Female curriculum developer) I think a lot of the instructional issues (e.g., workload, tenure, measurement) will have to be answered right up front. It is going to be one way for everyone and that you are not taking anything away. (Female teacher)

6.6.4 Question: What Are the Advantages and Disadvantages of Hiring a Graduate Trained the Constructivist Way Compared to the Traditional Way?

This key question focused on group members' perceptions of employers' responses. Some members are also local employers serving on the curriculum advisory boards. Others are university faculty who work with employers on a regular basis for placement, program planning, and so on. There was general agreement that employers today are looking for this kind (constructivist) of graduate. They prefer independent problem solvers, well-rounded generalists who "can do a variety of things," and the "learn as you go" type. Business employers also prefer "job-ready" graduates requiring minimum school-to-work transition time. Focus group members voiced no obvious disadvantages. However, employers in the groups showed skepticism with these traditional-educated graduates they had interviewed recently who seemed to be "out of the pool" and "introverted."

Although I did not collect as much feedback from employers as from educators, this does not pose a problem for the study as my objective was chiefly to discover the educators' perceptions of employers' response, not necessarily the employers' actual response.

6.6.5 Question: What Are the Difficulties You See in Implementing this Type of IT Program?

This last question addressed the difficulties focus group members saw in implementing this type of IT program and what it will take to make such a model work. First of all, there are perceived difficulties in organizing the curricula horizontally around problems rather than vertically around subjects. One real problem has to do with articulation and transferability of credits. If the program is not broken down into subject-based courses, then how can students transfer from one school to another and receive credits for what they have learnt already? They would have learnt a little about everything (e.g., database, programming, operating systems) in each authentically structured course. So it will be very difficult to map a problem-based syllabus to a subject-based syllabus. Secondly, the problembased syllabus will have difficulty gaining accreditation from professional associations like the ACM. As we discussed earlier, the ACM curriculum is essentially subject-based and not integrated. Finally, if the curriculum is to be organized around jobs, and not subjects, faculties felt that it will require much more work to keep up-to-date with the many job types in IT.

Cultural problems must also be overcome. Focus group members felt that other colleagues will also strongly resist these types of changes. Many will perceive a threat to their self-interest. For example, if courses have to be revamped, workload will be redistributed. Workload is not something to be tampered with casually. In most colleges, the distribution is arrived at through difficult negotiation and deep-seated traditions. If faculty workload is changed, then resources such as money and staff will be have to be redistributed as well. One female curriculum developer also perceived a possible "self-esteem" problem

when she said, "How can you explain to them (other faculties) that there is one right or wrong model to teach?" Another faculty remembered that whenever he teaches a course systematically "by the book," the students always give him a good evaluation for the course. On the other hand, whenever he tried something new, his course evaluations always suffered.

6.6.6 Question: What Will it Take to Make Such a Model Work?

Finally, focus group members suggested a number of ways to increase the possibility of success in implementing a constructivist curriculum model. These included the following:

- 1. Try to do a demonstration project within the school so others can see how it works operationally. Keep the pilot project on the side until it legitimizes itself.
- 2. Use an incremental approach by focusing on some job categories.
- 3. Secure the commitment of senior administrators by building a good business model to complement the pedagogical model, and convince key decision makers that it is in their best interest to make this change. Then, have the administration push the model down to the faculty level.
- 4. Provide both support and incentive to the faculties to implement the constructivist model, e.g., promotion, tenure, resources, and so on. Settle all instructional issues, such as workload and evaluation upfront. Ensure that faculty members have nothing to lose by going with the change.
- 5. Build faculty hiring and assessment around this model, and encourage or enforce curriculum mapping to satisfy the accreditation agencies.
- 6. Use a PUSH marketing approach by selling the idea to high school students and employers so that they will push the schools to change.

6.7 Summary and Implications

The purpose of the focus groups was to gain insights into five key questions regarding university IT programs based on a constructivist paradigm. By analyzing this very limited pool of university IT educators, I can summarize their feelings as follows:

- 1. There is a perceived need for IT education to move to some kind of constructivist pedagogy, especially within college-based programs.
- 2. Adult and college students will largely embrace such a change after a short period of intense struggle to adapt to it.
- 3. Teachers will most likely resist this change as it potentially threatens power relationships and personal interests.
- 4. Employers will most likely prefer graduates trained in constructivist methods to graduates from traditional programs.
- 5. Substantial difficulties will exist in implementing such a paradigm in collegebased programs. Pressure from the top as well as from outside the school will have to be exerted upon existing structures to make change happen.

Informed by and upon reflection of the findings of the focus groups, I proceeded to formulate my conclusions and recommendations to this study in the following chapter.

7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

7.1 Summary

7.1.1 Research Purpose and Questions

This study began with an assumption and a challenge. The assumption was derived from my practice experience: that constructivist educational theories have potential to significantly impact the current practice of IT education. The EdD challenge was to build theory from practice in order to improve practice. Thus, the purpose of this study was to develop a set of constructivist principles to guide adult IT education and training. This study was guided by five research questions:

- 1. What are the basic theories of constructivist pedagogy?
- 2. How can constructivist theories inform the practice of adult IT education, particularly in universities?
- 3. How can constructivist theories explain (or contradict) my experience as a learner and IT educator?
- 4. What are the essential principles that could be distilled from theory and experience into principles to guide adult IT education?
- 5. How will university IT educators respond to a constructivist approach to IT education?

7.1.2 Research Method

This study began by reviewing classical constructivist literature. Although the paths to Piaget, Vygotsky, and Dewey are well-worn, by keeping the context of my practice in focus, I was able to reap useful insights and arguments for the thesis.

Using these insights as a lens, the study turned to look at dominant practices in IT education to establish the need for a constructivist paradigm. I chose to examine two artifacts that represent a significant discourse on IT education: the IS 2002 standard for college-based programs and the IBM 4-Tier Model for organizational learning programs.

The study then moved introspectively to reflect on my own practice. Using Pratt's (1998) TPI as a lens, I identified my own teaching perspectives. I then reflected on my past experience and tried to find theoretical explanation for what I have already known about IT learning from experience.

I proceeded then to posit the Principles for Authentic IT Education. The principles, summarized in the phrase "IT education *in* the real world, *by* the real world, and *for* the real world," advocates authenticity in learning environment, context, mediation, and mission. It provides examples of authenticity as well as reflective questions to guide the practitioner.

As a formative evaluative step, I also obtained feedback on the constructivist IT educational approach from three focus groups at two Midwestern American higher educational institutes. These results were analyzed and used to inform the recommendations in this chapter.

7.2 Conclusions

This search began with the assumption that constructivist educational theories have the potential to significantly impact the current practice of IT education, and one way that could be done is through a theoretical framework to guide practice. Guided by the five research questions, this study has reached certain conclusions about this assumption. The following section draws conclusions to each research question.

7.2.1 What are the Basic Theories of Constructivist Pedagogy?

This study was built on four basic theoretical pillars: the cognitive constructivism of Piaget, the social constructivism of Vygotsky, the progressive education philosophy of Dewey, and the liberatory education of Freire. Piaget reminded us that all human beings, because they have to survive, are ready to learn by design. Vygotsky offered valuable insights into how real world things and people can mediate effective learning. Dewey provided an approach to curriculum whereby learning is organized around real world occupations rather than subjects; effective learning also moves from practical experience into formal knowledge. Freire stimulated me to ask the question, "For what?" and thus prompted me to broaden the problem domain to be addressed by IT education. The collective ideas of these four provided the necessary theoretical foundation to support the framework presented in this thesis.

7.2.2 How Can Constructivist Theories Inform Current Practice?

This study examined in depth two artifacts representing significant discourses in adult IT education: the ACM IS 2002 Model Curriculum and the IBM 4-Tier Blended Learning Model. Constructivist theories can inform and enhance the current practice of IT education in at least three ways. First, liberatory education theory can broaden the opportunities that adult IT education can address. Without a broader view of the problem domain to include social problems like poverty, health, oppression and so on, the growth rate of the IT industry and IT education is leveling off quickly. Secondly, the theories of social constructivism and progressive education can enliven IT education by organizing learning around real world problems and mediating learning through real world people and authentic tools. Finally, the theory of cognitive constructivism liberates the educator from overdependence on knowledge transmission and sequencing. Rather, it assumes that, as long as there is environmental pressure to adapt in order to survive, people will find ways to learn.

7.2.3 How Can Constructivist Theories Explain My Experience?

The principles presented in this thesis are, in a way, my attempt to systematize the best IT teaching and learning practices I have personally experienced in the past and to provide some theoretical support for them. Looking back, I can see how early failure in the school world forced me to learn in the work world in order to survive. In the work world, the knowledge construction process of assimilation, accommodation, and equilibration repeated itself over and over again. I adapted, survived, and thrived. At the same time, my success in training other IT employees on the job and in the constructivist classroom echoed Vygotsky's theory of cultural mediation as well as situated learning theories like cognitive apprenticeship and community of practice. Also, my educational volunteer work in mainland China led me to become more appreciative of liberatory education potential. At the same time, the philosophical roots of constructivism--Darwinian evolution and Marxist materialism--contradict my own Christian theistic worldview.

7.2.4 What are the Essential Principles?

This study posited a set of Principles for Authentic IT Education. The principles were purposely kept simple so they can be discussed and utilized in almost any adult IT education and training context. The principles can also be summarized in one sentence: Authentic IT education is situated <u>in</u> the real world, mediated <u>by</u> the real world, and practiced <u>for</u> the real world.

IT education <u>in</u> the real world concerns the principles of authentic environment and context. Effective IT education uses the environmental pressure inherent in the real world of

IT practice to energize the learner's natural cognitive adaptation capabilities. It also situates professional education around real world functions rather than a body of knowledge. It reflects how knowledge is picked up and evaluated in the real world rather than the school world.

IT education <u>by</u> the real world pertains to the principle of authentic mediation. Effective IT education is mediated by using real world tools, delivering useful real world products, and socializing the learning into a community of real world practitioners.

IT education <u>for</u> the real world deals with the principle of authentic mission. It emphasizes the need to align IT educational goals with institutional missions and moral actions in order to change human society. IT professionals must be educated to address not only business and engineering problems but also social and economic problems.

7.2.5 How Will University IT Educators Respond?

I took this question to three focus groups composed of 18 IT educators in two higher education institutions. I found that, among those interviewed, there is a need for collegebased IT education to move towards some kind of constructivist paradigm. Most teachers in the focus groups felt that students and employers will largely embrace the change to a more real-world approach to learning. However, the focus group exercises revealed that university teachers will probably resist changes that would upset existing instructional arrangements such as teaching load, performance evaluation, pay, tenure, and the use of adjunct instructors from the IT industry. Furthermore, universities are quite concerned that changing curriculum from a subject-based organization will complicate the accreditation process. All in all, substantial difficulties will exist in implementing such a framework in college-based

programs. Change will require leadership from the top as well as pressure from outside the school exerted upon existing structures.

7.2.6 Is this Framework Still Valid and Viable in 2007?

The lack of adaptability of the IT workforce trained in technical-rational environments is apparent today. When this study began in 2000, all of North America was experiencing an extreme shortage of qualified programmers. Talent-strapped firms were resorting to all kinds of stop-gap measures such as raiding other companies, creating unsustainable compensation schemes, importing labor, outsourcing offshore, and so on. Much has changed in seven years. Today, the locus of software development has moved from America to India. Offshore outsourcing has hollowed out many IT departments in banks, insurance companies, and industrial conglomerates. "To thrive in today's IT workforce, workers will need a mix of industry-specific skills and multidisciplinary background as more programming and coding work is moved offshore" (Hoffman, 2003, ¶ 1).

This study also reinforced my belief that a constructivist approach is an effective way to prepare adaptive, multidisciplinary IT professionals. Although this belief is substantiated only by my own practice experience, I am, nevertheless, more confident about its validity now than I was before the study. The focus groups also confirmed this view. We as teachers have observed that, through the use of constructivist methods, students develop a heightened ability to assimilate and accommodate to changing environmental threats by constructing knowledge necessary to survive and thrive.

On the other hand, along with this new confidence in constructivism, I have also gained new tolerance for more technical-rational models. These methods can fulfill some of the needs for performance, accountability, and e-learning. At the same time, the instructional

design school is also seeing the importance of authenticity and situated cognition in learning. De facto spokesman of the ID school M. David Merrill (2002) posited five First Principles of Instruction where the very first principle says, "Learning is promoted when learners are engaged in solving real-world problems" (p. 45). The fifth principle states, "Learning is promoted when learners are encouraged to integrate (transfer) the new knowledge or skill into their everyday life" (p. 40). I could even see how constructivism can co-exist with Ralph Tyler's (1949) four basic principles of curriculum and instruction. The first principle is one of purpose and outcomes. For me, that means outcomes that reflect the mission of the school as well as the requirements of the work world. The second principle is about the best educational experience. My answer is two words: real world. The third principle is about the fifective organization of the learning experience. For IT education, I have shown that cognitive apprenticeship and CoPs are very effective. The fourth principle concerns assessment. Again, for IT education, assessment has to be of an authentic and real world nature.

When it comes to the viability of the paradigm being adopted for college-based IT programs, I am less optimistic than when the study began. At that time I had just left ITI, where I had built a program almost from scratch. I was given strong support by the owners of the school, not because they understood constructivist theory but because I had a business track record with them in the past. I was empowered to build an educational business around a visionary learning model and succeeded. However, a university context is totally different. The nature of shared governance in universities means that power is distributed among a number of stakeholders. Faculties do not change unless there is overwhelming pressure from the top down that threatens their personal interests in some ways. Again, these behaviors are

almost universal and were confirmed by the focus groups in this study. Thus, the viability of a constructivist paradigm in college-based programs is directly proportional to the extent that pressure to change is applied. If pressure is high, as it is now with universities in Hong Kong, the paradigm is viable. Once the pressure is off, it will be less viable.

7.3 Recommendations

This study raised new practice possibilities for different audiences. This final section directs these possibilities as recommendations to three specific groups of practitioners: academic IT leaders, human resources development (HRD) professionals, and education practitioners and researchers.

7.4 Academic IT Leaders

7.4.1 Program Planning

Today, the highest priority for computer science deans and IT department heads is to have an urgent sense of mission for the future of IT education. Incoming computer science majors at U.S. universities have plummeted more than 60% between 2000 and 2004, according to data from the Higher Education Research Institute at UCLA (Gates & Klawe, 2005). I have argued in this thesis that, in order to reverse this decline, IT education needs to be solving the big problems of our world today and not just business and engineering problems. Operationalizing the Principle of Authentic Mission within current university structures can be done through the implementation of more interdisciplinary programs. For example, there are already many successful IT programs in education. How about IT in economic development, IT in social work, IT in international development, IT in public administration, IT and theology, IT in environmental science, and so on? Maria Klawe, past Dean of Science at UBC and current Dean of Engineering at Princeton University, has even

suggested an interdisciplinary "digital Pre-Med" program (CIPS, 2005) to prepare the brightest students to address healthcare problems using computer information technology. Klawe further suggested that, to attract and retain more students to IT, the very first computer course should be their best university learning experience. These ideas raise issues of curriculum and instructional development.

7.4.2 Curriculum Development

Within university-based IT programs there is an expressed need to design authentic IT curricula while, at the same time, satisfy current accreditation requirements. The first step towards authenticity is curriculum integration. We can see examples of curriculum integration at the high school level in science and math. IT curricula could be organized similarly into Integrated First Year Computer Science, Integrated Second Year Computer Science, and so on. Such a structure would gradually do away with compartmentalized core subjects like Programming, Data Structures, and Operating Systems. Once a commitment to integration is made, the Principles of Authentic Environment and Context can be used to guide the design of real world teaching, learning, and assessment materials.

A major concern about curriculum integration seems to center around the issue of accreditation. In my experience, there is no contradiction between the two issues. With some coordination among faculty members, it is no more difficult to assess specific academic outcomes in a problem-based integrated curriculum than in a compartmentalized subject-based curriculum.

7.4.3 Instructional Development

Many educational reform policies have been pushed down to the universities to promote institutional integrity, active learning, outcome-based criterion-referenced

assessment, and so on. In my experience in instructional development in North America and China, most teachers have little idea what those terms mean, much less the skills to integrate them into a cohesive and effective curriculum. Since compliance with policies affects university funding and career advancement, many teachers live under constant perturbation (in Piaget's term). I see a pressing need to provide training and mentoring to university departments on integrating constructivist pedagogy into an OBE framework. An effective framework for instructional development can be built on the principles of authentic environment, context, mediation, and mission advanced in this thesis.

7.5 Corporate IT Educators and Trainers

The principle of authentic mission applies not only to academic leaders but also to corporate IT educators and trainers. Since its inception, IT training has been dominated by the agendas of hardware and software product vendors. This kind of IT education views knowledge as primarily something that resides in manuals, CD-ROMs, or e-learning servers to be transmitted into the minds of the learner. Thus, most resources invested in this form of training only serve to feed the \$39 billion IT education and training industry rather than effectively advance the organizational mission or supporting the organizational strategy. So the first need for corporate IT educators is to realign IT training to support organizational mission and strategy.

Secondly, the principle of authentic environment and context also applies to corporate IT training. Since it is already difficult enough to make the school world more like the work world, there is no need to make the work world more like the school world. The real world of workplace problems and challenges already provides a rich context for learning without having to lean heavily on courses, seminars, instructors, exams, and all the paraphernalia of the school world. While a person sitting in front of an e-learning system can learn some things about IT, it is no comparison to the kind of learning that comes from participating in a community of practitioners working together creatively to solve real corporate problems. When learning is situated, it becomes part of everything we do and "virtually by definition eliminates the knowing-doing gap" (Pfeffer & Sutton, 2000, p. 251).

Finally, to recapture the IT learning agenda from the product vendors, it is crucial that corporate IT educators and leaders begin to look to the organizational socio-cultural environment rather than to technology vendors for solutions. The first step is to nurture the kind of corporate culture that advances learning--a culture with a bias for action over words, for sharing over hoarding of knowledge, and for making learning through mistakes possible. The next step is to see how day-to-day work can be organized so that learning can become an integral part of everything an organization does to advance its mission. For some organizations, it may be a form of mentorship or apprenticeship arrangement. For others, it may be through the use of cross-function teams in problem solving, application development, or software implementation. In all cases, the principle of authentic mediation--real people using real tools working together solving real problems--should guide the learning process.

7.6 Educators and Researchers

The framework advanced in this study has potential implications for one of the hottest issues identified by the American Federation of Teachers (AFT), the union representing university faculties in America (AFT, n.d.). The Principle of Authentic Mediation implies that part-time practitioner-teachers represent not only a financial alternative but also a pedagogical imperative. The goal of the AFT is to defend the interests of its full-time tenured members while, at the same time, seek equity for the 50,000 part-time faculty it represents.

The AFT, being a branch of the AFL-CIO, has only traditional union tactics such as organizing campuses and labor action, negotiating workload and compensation, and so on. There is no compelling educational reason, grounded in theory, to use part-time adjunct faculty--only financial reasons. It is also not obvious that schools fully appreciate the educational value of using adjunct practitioner-teachers. A brief search on the ERIC database turned up 269 papers on the keywords "Adjunct Faculty Development." A quick scan of the abstracts reviewed that most institutions focus on how to manage, orientate, and integrate part-time and adjunct faculties into their teaching departments. Efforts such as faculty mentoring and instructional workshops are designed to socialize the practitioner-teacher to function more like the tenured researcher-teacher, i.e., prepare lessons, give lectures, do assessment, and so on.

I believe that there is a need to develop a theory of adult education that affirms practitioner-teachers and integrates them into professional programs in such a way that fully utilizes their real world practice experience. A model of practice for the practitioner-teacher can begin by finding answers to the following research questions raised by the application of the Principles for Authentic IT Education:

- 1. What kind of practitioner-teachers (qualities and qualifications) are most effective in mediating authentic learning in professional programs?
- 2. How can adjunct practitioner-teachers and tenured researcher-teachers complement each other in an authentic educational process?
- 3. How can adjunct practitioner-teachers authentically contextualize learning for the student?

- 4. What kind of orientation/training is needed to integrate adjunct practitionerteachers to academe without making them into researcher-teachers?
- 5. What kind of research should practitioner-teachers do? What are the artifacts of authentic research? How should productivity for this kind of research be measured?

With a solid theoretical underpinning for the deployment of practitioner-teachers, part-time and adjunct faculties can no longer be viewed as "second class" teachers but as indispensable and equal partners in the education of future professionals.

Finally, the purpose of this study was to develop and evaluate a set of constructivist principles to guide adult IT education. The process of this search, which involved critical reflection on theory and practice, has changed me. I have become more committed to authenticity in educational methods and purpose. I have become more sensitive about changing the educational practices of others. I have become more focused on developing a practice that addresses the larger problems of IT and education. It is my hope that these thoughts will guide adult educators towards authenticity in other professional and vocational disciplines.

Endnotes

1.

A "technical rational" approach to education emphasizes measurable skills, performance, and procedures in educational processes.

Constructivism views learning as an active process in which the learner develops meaning by continually interpreting and responding to his or her experiences.
Consistent with this view of knowledge, learning must be situated in a real world context so reality can be <u>experienced</u> (by the learner) rather than <u>explained</u> (by the teacher).

- 3. Behaviorism views learning as a process where the learner responds to events (stimuli) in the environment. When a particular pattern of stimuli-response is reinforced by either reward or punishment, it will result in observable learning consequences, whether it is spelling a word correctly or solving a math problem accurately.
- 4. Cognitivism views learning in terms of mental information processing. Consistent with this view of knowledge, learning must focus on the environment and processes of learning. It defines successful learning as both understanding and skill performance.

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Appendix A



POWERPOINT PRESENTATION TO FOCUS GROUP

Current Problems:

- Shifting, exploding "body of knowledge"
- \boldsymbol{z} . The quest for relevance
- a. Changing business ∏ model
- Increasing "knowing-doing" gap
- s. School-to-work transition problems



Rational vs	s. Constructivist		
Explicit, declarative	Tacit, functional		
Decontextualized	Context-based		
Truth as validity	Truth as viability		
Knowledge explained	Knowledge experienced		
Formation from outside	Development fr. inside		
Goal is Performance	Goal is Adaptability		







- Extend problem domain from business and technology to social change
- Integrating practitioners into the entire teaching and learning process
- Use less academic "stuff" textbooks, term paper, exams, etc.
- Use industry manuals, websites, tools,

Teachers

- New roles as facilitators and project managers
- Not expected to "know everything"
- Minimal lecturing
- High involvement of practitioners as adjuncts to define learning projects, facilitate student learning, and assess outcomes

Discussion Questions

Impression

- What are the first things that come to your mind:
 - Is there a need for this kind of paradigm shift in IT education today?
 - Do you thank it will enhance or reduce quality of IT education?





Thank you!

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Appendix B

REPRESENTATIVE CAPABILITIES AND KNOWLEDGE EXPECTED FROM IS

PROGRAM GRADUATES

ANALYTICAL AND CRITICAL THINKING							
Organizational Problem Solving		Ethics and Professionalism		Creativity			
Problem solving models, techniques, and		Codes of conduct Ethical theory		Creativity concepts Creativity techniques			
approaches		Leadership		The systems approach			
Personal decision making		Legal and regulatory standards			,		
United thinking		Professionalism - self directed,					
Methods to collect, summarize, and intermet data		Professionalism - commitment to and					
Statistical and mathematical		completion of work					
methods		completion of noin					
BUSINESS FUNDAMENTALS							
Business Models Functional Business Area		as Evaluation of Business Performance					
Contemporary and emerging		Accounting		Benchmarking			
business models		Finance		Value chain and value network analysis			
Organizational theory,		Marketing		Quality, effectiveness, and efficiency			
structure, and functions		Human Resources		Valuation of organizations			
System concepts and theo	ries	Logistics and Manufactur	ing	Evaluation of investment performance			
INTERPERSONAL, COMMUNICATION, AND TEAM SKILLS							
Interpersonal		Team Work and Leader	ship	Communicatio	מו		
Listening		Building a team		Listening, observing, interviewing, and			
Encouraging		Trusting and empowering		documenting			
Motivating		Encouraging		Abstraction and precise writing			
Operating in a global, culturally		Developing and communicating a		Developing multimedia content			
קיאנצה פהאתמשוופטנ		VISIOD/RESSION		Writing memos, reports, and			
		Seming and macking team goass					
		Negonating and tachitating		Gwing enecuw	e presentanois		
		Constraint in a nighted toop					
		enstroiment					
		Reing an effective leader					
TECHNOLOCV							
Amplication	Infer	at Systems	Defense Decime and Surface Infractionethy		Systems Infrastructura		
Development	Archi	terture and	Administration		and Inferration		
Deremptacat	Develo				and megration		
Programming-	Web r	oage development	Modeling and design		Computer systems		
principles, objects,	Web a	irchitecture design and	construction schema tools.		hardware		
algorithms, modules,	development		and DB Systems		Networking		
testing	Design and development of		Triggers, stored procedures,		(LAN/WAN) and		
Application	multi-tiered architectures		design and development of		telecommunications		
development –			audit controls		LAN/WAN design and		
requirements, spec's,			Administration: security,		management		
development			safety, backup, repairs,		Systems software		
Algorithmic design,			and replicating		Operating systems		
data, object, and file					management		
structures					Systems configuration.		
development					operation, and administration		
INFORMATION SYSTEMS = TECHNOLOGY-ENABLED BUSINESS DEVELOPMENT							
Systems Analysis and Design, Business Process Design, Systems Implementation, IS Project Management							
Strategic utilization of information Systems analysis Deployment							
technology and systems Logical and physical design Maintenance							
IS planning Design execution Use of IT							
IT and organizational systems Testing Customer service							
Appendix C

ARCHITECTURE OF THE IS 2002 CURRICULUM



Curriculum Presentation Areas



Figure 3. IS 2002 Representative Course Sequence

Appendix D

CURRICULUM PRESENTATION AREAS FOR IS CURRICULUM



Appendix E

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KNOWLEDGE DEPTH LEVELS OF IS 2002 CURRICULUM

IS'90,'94,'95, 2002 Depth of Knowledge	Bloom Levels of Knowledge	Template for Writing Behavioral Objectives Students completing will be able to	Meaning of Depth of Knowledge Level and Activities Associated with Attaining that Level
0 No Knowledge			
1 Awareness	l Knowledge Recognition	Define List characteristics of Name components of Diagram List advantages/disadvantages of	Introductory Recall and Recognition Class presentations, discussion groups, reading, watching videos, structured laboratories. Involves only recognition, but with little ability to differentiate. Does not involve use.
2 Literacy Strong Knowledge	l Differentiation in context	Compare and contrast Explain Write/execute simple Define functional capabilities that are Describe interrelations of to related objects	Knowledge of Framework and Contents, Differential Knowledge Continued lecture and participative discussion, reading, team work and projects, structured labs. Requires recognition knowledge as a prerequisite. Requires practice. Does not involve use.
3 Concept/Use Skill	2 Comprehension Translation/ Extrapolation Use of Knowledge	Use Communicate the idea of Form and relate the abstraction of as Given a set of, interpolate/extrapolate to List concepts/major steps in	Comprehension and Ability to Use Knowledge when Asked/Prompted Requires continued lab and project participation, presentation involving giving explanations and demonstrations, accepting criticism; may require developing skills in directed labs.
4 Detailed Understanding, Application Ability	3 Application Knowledge	Search for correct solution to and apply it to Design and implement a for Write syntactically correct and/or debug Apply the principles of to Implement a and maintain it	Selection of the Right Thing and Using It without Hints Semi-structured team-oriented labs where students generate their own solutions, make their own decisions, commit to and complete assignments, and present and explain solutions.
5 Advanced	4 Analysis 5 Synthesis 6 Evaluation	Develop/originate/institute Construct/adapt Generate novel solutions to Come up with new knowledge regarding Evaluate/judge the relative value of with respect to	Identification, Use and Evaluation of New Knowledge An advanced level of knowledge for those very capable of applying existing knowledge in which <i>denovo</i> solutions are found and utilized in solving and evaluating the proposed new knowledge.

Appendix F

IBM 4-TIER LEARNING MODEL

