## ABSTRACT

BEELER, JAMES E. Toward an Adult Learning-Based Theory of K12 Educator Professional Learning for Technology Adoption. (Under the direction of James Bartlett).

This study identifies a gap in the literature about K12 educator professional learning for technology adoption. Technology adoption models and professional development frameworks do not intentionally leverage adult learning theory to specifically address the learning of K12 educators. The purpose of this study is to use adult learning theory (primarily andragogy and transformative learning) to create a theory of K12 educator professional learning for technology adoption. The study uses an 8-step theory-building research methodology developed by Dubin (1978). After introducing the topic, surveying the literature and describing the methodology, the study progresses through the eight steps of Dubin's theory-building research model, including Units, Laws of Interaction, Boundaries, System States, Propositions, Empirical Indicators, Hypotheses, and Research to create and operationalize the new theory. Instead of conducting the research to test the theory, Dubin's final step, this study follows a format used by others to propose a research agenda for testing the theory. The study evaluates the theory using Patterson's (1986) eight criteria for evaluating theories.

Limitations of the study include that it applies only to K12 educator professional learning for technology adoption, that by focusing on Dubin's theory-building model it excludes other theory-building methodologies, and that the theory has not been tested through empirical research.

The study resulted in a new theory, the adult learning-based theory of K12 educator professional learning for technology adoption. A conceptual model was developed that

outlines the units and their interactions, the boundaries, and the system states of the theory. The study identified the following units that influence K12 educator professional development for technology adoption: personal context, interpersonal context, the physical, digital, and policy environments, readiness to learn, and transformative learning. Personal context and the environment units have a direct relationship with interpersonal context and readiness to learn. Readiness to learn and interpersonal context have a direct relationship with transformative learning.

Implications for the study include building a bridge between adult learning principles and K12 educator professional learning for technology adoption. The theory developed in this study could support professional learning planners and those planning for significant technology implementations. This study brings together the fields of HRD and K12 educational technology and professional development. Future research opportunities include conducting research on segments of the adult learning-based theory of K12 educator professional learning for technology adoption and using a similar methodology to develop, conceptualize, and operationalize other theories for K12 education.

# Toward an Adult Learning-Based Theory of K12 Educator Professional Learning for Technology Adoption

by
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## DEDICATION

This work is dedicated to my wife, Annette Beeler, who encouraged me every step of the way, who willingly engaged in late night talks about theory building, who gave up many, many weekends, and who makes my life an incredible joy. We did it, Sweetie!

## BIOGRAPHY

Jim Beeler is the Chief learning Officer at Digital Promise, a non-profit focused on accelerating innovation in education. Prior to that Jim worked at Apple, Inc., where he was a Senior Specialist and Development Manager as well as the National Senior Manager of Professional Development. Jim's career at Apple included working in a wide variety of large and small urban, suburban, and rural school districts, and on many laptop and tablet one-to-one projects. Prior to his work at Apple, Jim owned a consulting business that provided professional development, software development, peer-coaching and change management consulting in the area of education technology. Jim taught middle and high school social studies and was a technology coordinator. Jim's education includes a B.A. and M.A. in history from the University of Tennessee and Appalachian State University, respectively, and doctoral-level curriculum and technology studies at the University of Texas at Austin.

## ACKNOWLEDGMENTS

First and foremost I must thank James Bartlett, the chair of my committee, for providing just the right amount of help and advice throughout the program, starting from our first ‘Is this the right program – am I the right candidate?’ phone call. Thank you, Dr. B! I hope that you know how much you do to enrich the lives of those around you.

Led by my wife, members of my family filled the cheering section at every stage, happy to listen to my stories about grad school, always ending the conversation with a ‘You can do it!’ of some sorts. I am lucky to have a mom who has always encouraged me to stick with it, to try the next step, to reach a little higher.

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# CHAPTER ONE

# INTRODUCTION

This study focuses on using adult learning models to develop and operationalize a theory for educator professional development for technology adoption. Developing the theory will follow a structured research-based process that results in a conceptual framework. Operationalizing the theory will result in a research framework. Together the conceptual framework and the operationalized research framework make up the findings of this study.

This chapter which introduces the study is divided into the following six sections.. First, the nature of the problem that includes an introduction of educator technology adoption models to provide a broad background for the study will be discussed. Second, a brief overview of two adult learning models is presented. The third section briefly discusses the use of theory in human resource development (HRD) research and introduces theory-building research. The fourth section identifies the problem and the need for the study. The fifth section identifies the significance of the study to educator professional development. The last section of this chapter provides an overview of each of the subsequent chapters in the study.

## Nature of the Problem

### The Challenges and Opportunities of Working in a Global World

In the opening chapter of a volume that brings together educational technologists from around the world to rethink the direction of schooling and the impact of technology, the authors start out by explaining social informatization, a Chinese academic construct little-known to western academia (Huang, R., Chen, G., Yang, J., & Loewen, J. 2013). Social

informatization occurs when national social and economic structures transition from a physical to an informational space, and is "the gradual coupling process of the digital world and the real world" (p. 5). Made possible by the incredible advances in technology, more people experience more access to more information in more aspects of their lives at an accelerating pace. This increasing access to more information makes us more efficient and more challenged to keep up with the pace of change. "Social informatization makes people aware of the convenience of accessing information, but in the face of a large volume of information, individuals will also feel overwhelmed and frustrated due to the abundance of irrelevant information" (Huang, et al., 2013, p. 5).

Social informatization changes what society needs from education to focus much less on book-based consumption and recall of information toward much more focus on knowing how to learn, collaborate, and process information using communication and information technology tools. "Experiential learning, with participation in activities and problem solving in groups, combined with the virtual world will gradually become the mainstream way of learning" (Huang, et al., 2013, p. 6). One way to describe the new needs of education is connected learning.

Although the term informatization generally has not been adopted by American academia (Huang, et al., 2013), many Americans would agree and write about what the coupling of the digital and the real world means to society and more specifically what it means to education. The following section highlights the challenges and opportunities presented by what Chinese call informatization.

In The World is Flat: a Brief History of the Twenty-First Century (Friedman, 2005) the author describes what he calls Globalization 3.0, driven by personal computers, the Internet, and workplace-efficient software. These technologies flatten the economic competitive landscape, make knowledge accessible to everyone, and speed up the pace of innovation. To succeed in such a world workers must be skilled in the use of new technologies and business strategies. Doing so requires a rethinking of education toward focusing on new, 21st century, skills (Friedman, 2005).

Naim (2009), in a foreign policy piece, argues that globalization, driven by the Internet, is far more than an economic movement. It allows for the cultural exchange of ideas and democratization of knowledge at unprecedented speed and breadth of access. Globalization is here to stay and citizens must prepare to leverage its speed and reach to organize their lives in order to solve both local and global challenges.

Pink (2005) sums up the realities of a flat world in three words: Abundance, Asia, and Automation. Pink describes abundance as the number of consumers and the amount and variety of offerings available to them. He further notes that the ability to choose and attain those offerings has greatly increased through a global economy. Pink insists that today's workers must find ways to differentiate what they offer, to be unique, relevant and necessary. This becomes more difficult when considered against Pink's next two points, Asia and Automation (Pink, 2005).

Pink refers to Asia as the huge increase in the number and nationality of skilled workers who can complete tasks that require directed thinking – that is – to follow a complex set of instructions. Beyond factory workers, Pink includes accountants, engineers, medical

technicians and other jobs that typically require a college degree and/or a graduate degree in this group. American graduates must prepare to compete for work against graduates from across the world (Pink, 2005).

Pink states that any job that can be logically analyzed and computerized as one that is or will soon be automated. Workers must have skills that computers cannot process. In a world where one must compete against a growing educated workforce and ever-increasing automation, distinguishing oneself or a product as unique, relevant and necessary becomes quite a challenge. Pink labels this new age, beginning roughly with the 21st century, the conceptual age. He identifies six senses that should be emphasized to prepare for the work of the future: Design, Story, Symphony, Empathy, Play, and Meaning (Pink, 2005).

Another model that responds to the challenges of globalization outlined by Friedman and Pink uses the "Cs" mnemonic. The 'Cs' include the following six competencies: convergence, curriculum, customization, collaboration, and connectivism (Anderson-Inman, 2009). The author concludes that, "Digital technologies and online communications can play a major role in promoting future consciousness, in part because of their capacity to stretch the way we interact with information and media, and in part because the internet provides transformational opportunities to work on authentic problems in collaboration with people and organizations worldwide" (Anderson-Inman, 2009, p. 136).

Along a similar pathway, Howard Gardner (2006) identifies five minds that schools should focus on to prepare students for the future. These include The Disciplinary Mind, The Synthesizing Mind, The Creating Mind, The Respectful Mind, and The Ethical Mind. Both

Pink and Gardner position technology as a tool that may enhance or transform our ability to utilize these six senses and five minds (Gardner, 2006; Pink, 2005).

Azzam (2009) interviewed Sir Ken Robinson, focusing on the importance of creativity as a critical skill for the 21st century that must be addressed by educators. Creativity and innovation require continuous critical problem solving and evaluation, and connect us to our passions (Azzam, 2009). Indeed, some would argue that the competitive advantage of American students is the combination of creativity and innovation in digital technologies in the United States (Zhao, 2009).

In writing about how schools need to change Tony Wagner (2008) identifies seven survival skills that students need to succeed in the new world of work: 1) critical thinking and problem solving, 2) collaboration across networks and leading by influence, 3) agility and adaptability, 4) initiative and entrepreneurialism, 5) effective oral and written communication, 6) assessing and analyzing information, and 7) curiosity and imagination. These survival skills align with the senses of Pink, the minds of Gardner, the Cs of Anderson-Inman, and Robinson's focus on creativity. Technology becomes completely intertwined in learning and applying the Wagner's survival skills when one considers ways that students of the 21st century work and learn. Today's learners multitask and connect online constantly, expect instant feedback and access to knowledge, expect access to multimedia resources to help them, and learn through discovery, connecting to others and by creating (Wagner, 2008). Technology tools make all of this possible.

Identifying the skills necessary to succeed in the 21st century economy requires, at the least, an indirect but firm link connecting the technology tools that power the global

innovation with what is being taught in schools. What is more important is the obligation of the schools to ensure that graduates know how to use technology to apply the survival skills, the senses, the "Cs," and the minds (Anderson-Inman, 2009; Azzam, 2009; Gardner, 2006; Pink, 2005; Wagner, 2008).

Educators should use technology to empower 21st century students. As much as students know about technology they may not know how to apply the tools to become intelligent, creative, and effective learners. Lemke and Coughlin (2009) write that technology changes the nature of learning in four ways: the democratization of knowledge, participatory learning, authentic learning, and multimodal learning. Schools should leverage these four changes by seeking out and incorporating new technologies to engage and differentiate, designing for self-directed and authentic learning, and promoting a variety of tools for publishing, collaborating, and communicating with other learners and experts (Lemke & Coughlin).

Prensky (2013) asserts that learning to use technology may be the most necessary skill schools should help students learn, more so than reading. For example, text-to-speech and dictation tools allow those who cannot read or write to become literate without having to read or write while they listen and dictate. The human mind as it has been used in the past is not powerful enough to cope with a complex world in a constant state of rapid change (Prensky, 2013). In the past, learners and teachers did the intellectual heavy lifting then decided which tool to use for expression (e.g., word processing, presentation, or movie-making software). Today's learners use technology to extend their cognitive processing (e.g., smart phone usage). Technology, now part of mental activity and not just an addition to it,

provides the enhancement our minds need to meet the demands of the global environment. Learning and the use of technology exist in a symbiosis where not having technology tools available leaves students deficient as thinkers (Prensky, 2013).

To summarize, two certainties emerge from the writings of Friedman, Pink, Anderson-Inman, Azzam, Wagner, Lemke and Coughlin, and Prensky. One, today's rapidly changing, increasingly automated global economy means that the competition for good jobs requires workers to possess skills such as flexibility, creativity, the ability to communicate in a variety of formats to a variety of people, and the ability to use curiosity, imagination, initiative, entrepreneurialism, and problem solving to synthesize and create new meaning. Two, applying these skills requires the ability to use a variety of technology tools and preparing graduates to succeed in today's global environment, including incorporating the use of technology.

## Models that define 21st century skills

A variety of theories and models have been used to both describe and prescribe how K-12 educators implement technology in support of teaching and learning. These models are applied in the planning, implementation, and reflection on teachers' professional development and professional learning experiences that help them integrate technology in education. The models generally describe a change process and/or delineate incremental steps regarding approaches to using technology. Examples of the models include the Technology Adoption Model (Davis, 1989; Vinkatesh, 2000), the Apple Classrooms of Tomorrow Model (Dwyer, 1994; Sandholtz, 1996), and the Concerns Based Adoption Model (Hall 1975, 1976a, 1976b).

These models and frameworks offer guidance for educators to implement the use of technology and organize frameworks for their professional development in the use of technology in the teaching and learning process. They include such variables as motivation, attitude towards using technology, perceived ease of use of the technology, perceived usefulness of the technology (Davis, 1989; Venkatesh, 2000), perceived skill level of the educator (Dwyer, 1994; Sandholtz, et al, 1996) perceived skill level of the students, perceived administrative support (Hall, 1976a, 1976b), and professional development (Dwyer, 1994; Partnership for 21st Century Skills, 2006; National Staff Development Council, 2009), all with the purpose of integrating technology into lesson design and implementation with students.

As the 20th century drew to a close, organizations connected to public policy discussion and frameworks regarding workplace skills and education began to define the skills that workers would need to succeed in the 21st century. In 1991, the United States Department of Labor Secretary's Commission on Achieving Necessary Skills issued what was perhaps the first 21st century skills document, titled What Work Requires of Schools: a SCANS Report for America 2000 (United States Department of Labor, 1991). In addition to defining a set of broad based skills that went far beyond the "three Rs," such as collaboration, the use of technology, and problem solving, the SCANS report called for closer ties between schools and industry to make the connection between what was taught and what businesses required more obvious.

Other organizations that influence the way educators think about and use technology to support teaching and learning include the International Society for Technology in

Education (ISTE, 2008), the National Staff Development Council (later known as Learning Forward) (Hirsch, 2009; Learning Forward 2012; NSDC 2001, 2009), and the Partnership for 21st Century Skills (P21, 2006, 2007).

These professional organizations provide good models and frameworks to help one determine how to organize content in the areas of 21st century skills, the use of technology, and educator professional development. The Partnership for 21st Century Skills (P21) created a framework that describes 21st century skills in the broader context of education and schools (P21, 2007). The International Society for Technology in Education (ISTE) developed the National Education Technology Standards (NETS), delineating for students, teachers, and administrators, among others (ISTE, 2007, 2008, 2009). The National Staff Development Council (NSDC) provides design principles for organizing professional development experiences for educators (Hirsh, 2009 Learning Forward, 2012; Wei et al., 2009). The models created by these organizations, provide guidance to those who seek to use technology to implement the teaching and learning of 21st century skills in schools.

However, with a few minor exceptions, the models generally do not specifically highlight principles of adult learning theory. When educators talk about learning in a world focused on maximizing student learning and performance, they almost always mean student learning (ISTE, 2008; NSDC, 2009). Knowles (1973) labeled the idea that the way we teach children (pedagogy) also becomes the way that we teach adults the "millstone of pedagogy" (Knowles, 1973, p. 42). To compound this, teachers' beliefs about pedagogy may have been formed as students, in a structured system with strong authority figures and, therefore, very difficult to change (Ertmer, 2005; Lortie, 2002). Lortie called this the "apprenticeship of

observation" (p. 62), where by virtue of attending school, one experiences years of exposure to teachers teaching children, which establishes hardened ideas about teaching and learning, and thus, carrying forward the tradition of pedagogy. Ironically, then, when confronted with their own learning situations, educators may need to be reminded about adult learning principles.

This study uses two adult learning theories, andragogy, as defined by Malcolm Knowles (1973, 1984), and transformative learning, as defined by Jack Mezirow (1991, 1997), to explore a set of conditions and learning experiences that could inform professional development for K-12 educators in technology adoption.

## Purpose of This Study

This study will explore the adult learning implications in prominent professional development models from ISTE, P21, and NSDC for learning how to use technology to implement teaching and learning of 21st century skills in schools as well as technology adoption models for understanding how teachers adopt new technologies into their professional practice. Do the models include principles of adult learning as defined by andragogy and transformative learning? If so, how much emphasis do the models place on the elements of adult learning and the design of professional learning experiences? This study will suggest design elements for professional learning in technology and 21st century skills that specifically embrace adult learning theory. This study uses andragogy as defined by Malcolm Knowles and transformative learning as defined by Jack Mezirow to explore a set of conditions and learning experiences that could inform professional development for K-12 educators in the areas of technology and 21st century skills.

## Problem Statement

If PK-12 educator professional development for implementing technology does not intentionally call out elements of adult learning theory then some educators may fail to fully engage as learners. If the theoretical models used to create technology professional development for educators do not specifically include elements of adult learning theory then some models of professional development may not successfully engage all educators as learners. Human Resource and Development (HRD) researchers such as Malcolm Knowles and Jack Mezirow identified distinct adult learning theory. However, a gap in the research exists regarding the use of adult learning principles in technology adoption models and educator professional development to support the use of technology in the process of teaching and learning. New theory is needed that applies adult learning theory to models for educator technology adoption. Such theories will inform professional learning possibilities for educators.

## Purpose Statement

The purpose of this study is to use adult learning theory to conceptualize a broader theory of educator professional learning and technology adoption and to develop a framework that operationalizes the theory.

## Theoretical Framework

This study relies on Dubin's (1976) 8-step process for theory building. Dubin's method is divided into three main areas, conceptualizing the theory, operationalizing the theory, and analyzing research on the theory. This study uses Dubin's 8-step process for

theory building and the 20 years of experience of the researcher-theorist in delivering technology professional development to educators to develop a theory of educator technology adoption. This theory-building method has been described by Dubin (1978), Lynham (2002), Holton and Lowe (2007), and Garcia (2008). The findings of this study will show results in the two areas of Dubin's theory-building method, conceptualizing the theory and operationalizing the theory. This study will not conduct or analyze research on the theory; that work will be left for other studies.

## Conceptual Framework

Examining technology adoption models opens a discussion about ongoing efforts to understand how and why educators adopt and use technology in support of teaching and learning. This naturally leads to an examination of professional learning models and the connection of professional development practices to technology adoption. Both the technology adoption models and the professional development models include elements of adult learning theory, but this inclusion seems more ad hoc than planned or intentional. Figure 1 shows the relationship of these models to a technology implementation in K12 education.

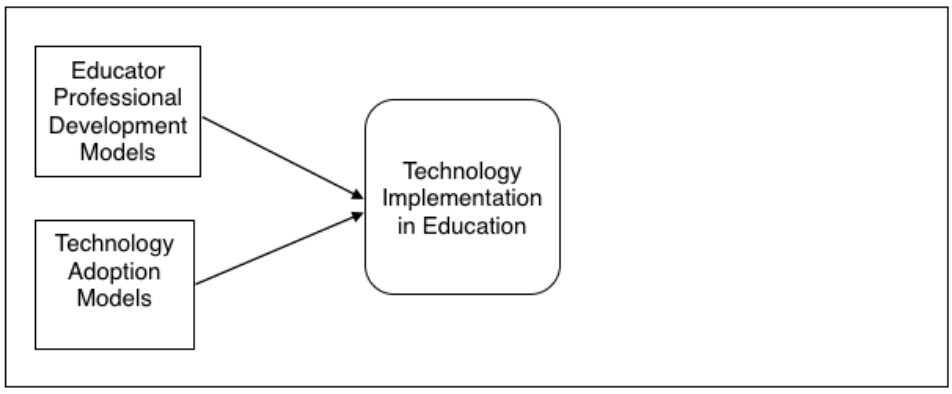


Figure 1. Use of theoretical models in K12 education technology implementations.

Thus, a gap exists in the current technology adoption and educator professional development for technology models in the area of including adult learning theory. Examining adult learning theory opens a pathway for an approach to educator learning and technology adoption that purposefully utilizes adult learning principles. This study examines the gap and uses theory-building research techniques to create a new adult learning-based theory of educator professional learning and technology adoption. Figure 2 shows the conceptual model for this study.

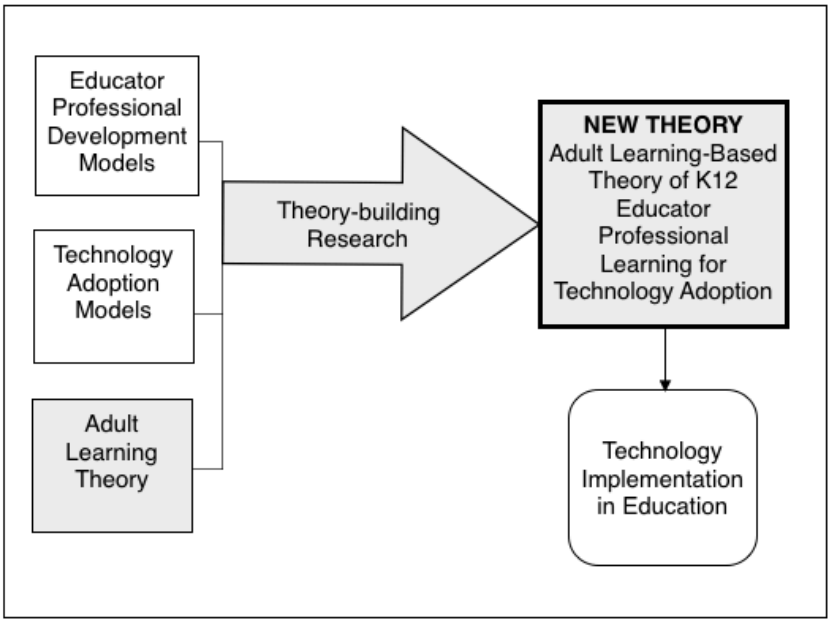


Figure 2. Conceptual model for creating the adult learning-based theory of K12 educator professional learning for technology adoption.

## Research Questions

(1) Can adult learning theory be used to develop a theory of K12 educator professional learning for technology adoption?

(2) Can adult learning theory be used to conceptualize a theory of K12 educator professional learning for technology adoption?

(3) Can an adult learning based theory of K12 educator professional learning for technology adoption be operationalized?

## Significance of Study

School districts that implement technology will benefit from increased understanding about how educators adopt new technologies in their professional practice. Those who plan, deliver, and facilitate professional development to K-12 educators will benefit from a new theoretical design model. Educators may be able to use the new model as a tool for self-reflection and self-directed learning.

## The Structure of the Study

Chapter One introduces the study, discusses the nature of the problem, and provides a problem statement and purpose statement. The chapter introduces adult learning theory from Malcolm Knowles and Jack Mezirow, forms research questions, and highlights the significance of the study. Chapter Two provides a review of literature on educator technology adoption models, professional learning for educator use of technology, adult learning theory, and theory building research. Chapter Three describes the methodology used in conceptualizing and operationalizing the theory. Chapter Four works through the first four steps of Dubin's (1978) model, conceptualizing the theory. Chapter Five describes the operationalization of the theory and evaluates the theory using Patterson's (1986) theory evaluation criteria. Chapter Five ends with a discussion of the limitations and implications of the study.

# CHAPTER TWO

# REVIEW OF LITERATURE

This study focuses on creating an adult learning-based theory of educator technology adoption. This chapter reviews the related literature and consists of four sections. Each section reviews pertinent literature and concludes by identifying key conceptual building blocks. The first section reviews literature on technology adoption models used in education. These models are referenced to measure how educators adopt technology into the teaching and learning process, to guide the content and course of professional development, and to plan for technology adoption implementations. The second section reviews literature on adult learning theory, focusing specifically on andragogy from Malcolm Knowles and transformative learning from Jack Mezirow. The third section reviews literature on the theory building research process, with emphasis given to the area of human resource development (HRD). The final section of this chapter summarizes important postulates from the review of literature and defines key concepts for the study.

## Technology Adoption Models

The first section of this chapter provides a general discussion about ways to think about technology adoption, technology integration, and what educators experience as they adopt technology to support teaching and learning. Next the section identifies technology adoption models, one focused on technology in general, one focused specifically on technology adoption by educators to support teaching and learning, and two on what people experience in adopting innovations. The next sections describe the models in some detail. The last section summarizes the examination of the technology adoption models and adds

comments about how they may be used to create an adult learning-based theory of educator professional learning for technology adoption.

In writing a recent 20-year retrospective about influential policy documents in education technology in K-12 education, the authors started with the famous 1983 federal report, *A Nation at Risk,* which recommended that computer science almost become the fifth core subject required for high school graduation. By computer science the authors meant that students should understand how to use computers to access information, communication, and productivity tools for personal and work purposes (Culp, Honey & Mandinach, 2005; National Commission on Excellence in Education, 1983). This call for making sure that American students know how to use technology tools continued in the federal No Child Left Behind Report (NCLB) (Elementary and Secondary Education Act ESEA, 2001) and, indeed, continues with the National Education Technology Plan (NETP) from the Obama administration (U.S. Department of Education Office of Educational Technology, 2010).

The larger issues around technology adoption in education are complex and broad. From the initial question of whether technology gets adopted into educational practice, the subsequent questions of if, how, why, where, when and by/for/with whom technology gets adopted quickly broaden the discussion. Those who seek to understand technology adoption in education typically employ theoretical models to categorize, explain, and perhaps even predict educators' behavior in terms of using technology.

This results in the identification of major types of models on technology adoption in education and traces the influence of major researchers in each area and their models. Doing this creates a framework for synthesizing the research about technology adoption in

education. Although the models may apply to both the K-12 and higher education areas, this study focuses primarily on how K-12 educators adopt technology. Exceptions to this will be noted; otherwise, referring to educators means K-12 educators.

Jones (2011) distinguishes the following between technology adoption and technology integration. She notes technology adoption describes a more top-down driven process of whether to use technology in schools whereas technology integration describes a more teacher-driven process of using technology in teaching and learning (Jones, 2011). Parsing these definitions is tricky business at best. Perhaps a better way to look at this may be that the terms have been used interchangeably over time. What started as technology adoption by schools turned into technology integration once schools reached the tipping point of acquiring technology. Some researchers even suggested that the term technology integration should not be used (We don't think of pencil and paper integration, do we?) as it feels too much like an add-on (Utecht, 2007).

Those working in educational technology sought to define technology integration and get past the idea that it may have been considered an add-on for teachers (e.g., PowerPoint project). Perhaps a turning point in the research that changed the conversation from just putting technology in schools to also making efforts to ensure that teachers know how to use the technology in the teaching and learning process, came during the Apple Classrooms of Tomorrow (ACOT) research from 1986-1996. Researchers found that, over time, teachers transitioned their instructional practices to become more student-centered and constructivist, and less didactic and traditional (Dwyer, 1994). This change in teacher belief about how technology can be a catalyst to support the transition toward student-centered teaching and

learning, and the model that ACOT researchers developed to describe the change, helped to define what technology integration means (Jones, 2011; Moersch, 1995; Sandholtz, Ringstaff & Dwyer, 1996). While still useful, the phrase 'technology integration' sometimes is used interchangeably and/or as distinct from other phrases such as technology infusion and technology implementation.

Significant ideas in educational technology have evolved over time. The National Educational Technology Standards for Students (NETS-S), created by the International Society for Technology in Education (ISTE), transitioned from focusing on learning how to use technology tools (ISTE, 1998) to learning skills that apply across a variety of tools (ISTE, 2007). Karen Cator, the former Director of the Office of Educational Technology in the U. S. Department of Education, now dismisses the once popular idea that teachers, as "digital immigrants," do not naturally embrace technology the way the millennial generation of "digital natives" students do (Bennett, 2010; Prensky, 2001; Scherer & Cator, 2011). "We need to get beyond calling teachers digital immigrants, as if technology holds a certain code only young people can decipher," says Cator (Scherer & Cator, p. 20).

Likewise, the notions of technology adoption and technology integration and other terms in education have evolved to just focus on using technology that helps students meet learning goals (Scherer & Cator, 2011). Chris Moersch (2010), in describing the change in his LoTi model from levels of technology integration to levels of teaching innovation, uses the term technology implementation, describing it thusly: "The outcome of becoming a LoTi Digital Age School is increased student engagement, a higher level of technology implementation in each classroom, and improved student achievement" (p. 23). Just as

significant ideas in education technology have evolved, so have the theoretical models used to describe, explain, and predict the progress of technology adoption. Unless otherwise noted, this study will use the term technology adoption to include adoption, integration, infusion, and implementation.

Technology adoption models in education can be divided into three categories: (a) models that focus on the Technology Adoption Model (TAM); (b) models that trace their beginnings to the research coming out of the Apple Classrooms of Tomorrow (ACOT) project; and (c) models that utilize a change model to explain how individuals are impacted by the process of adoption such as the Concerns Based Adoption Model (CBAM). This review of literature will discuss each of these categories of technology adoption models.

In addition to technology adoption models, a second way to think about technology adoption in education concerns the largely financial issues of access to technology versus the philosophical issues of how and why technology should be used. This review of literature will leave aside the issue of access, considering instead the issues of how and why educators choose to use (or not use) technology and the efforts made by researchers to discover patterns that might promote technology adoption in education.

## The Technology Adoption Model

The Technology Acceptance Model (TAM), developed by Fred Davis, focuses on two self-reported measures, perceived usefulness and perceived ease of use, as the determinants that influence both the intent to use and the actual use of information technology (Davis, 1989). The TAM defines perceived usefulness as that using a system will improve job performance and perceived ease of use, and that using a system will be relatively

effortless. Perceived ease of use also influences perceived usefulness because, if all other factors are equal, the system that is easier to use will be the more useful (Venkatesh & Davis, 2000). Either determinant may influence the decision to use a technology system, although early research favored perceived usefulness as a more significant indicator than perceived ease of use (Davis, Bagozzi, & Warshaw, 1989). Figure 3 displays the TAM model and the relationship between perceived ease of use, perceived usefulness, and the intent to use a technology. Early research identified perceived usefulness as the stronger indicator on intent to use (Chuttur, 2009).

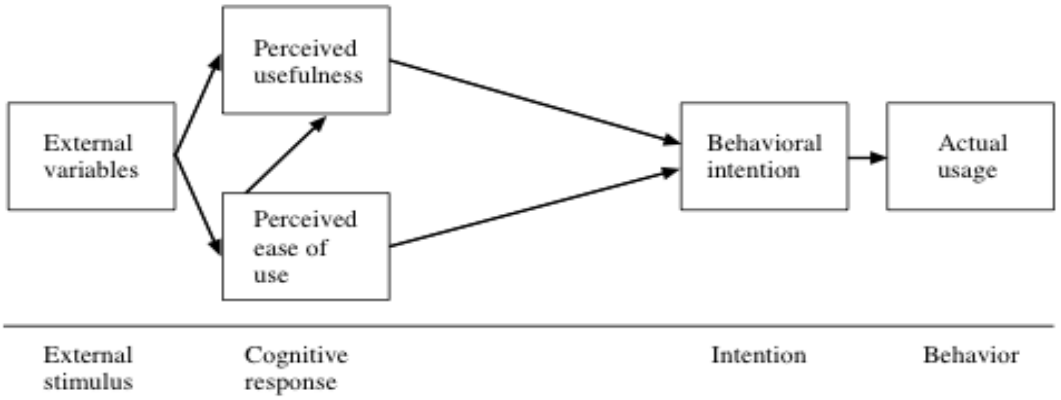


Figure 3. Technology Acceptance Model (TAM). From "A model of the antecedents of perceived ease of use: Development and test," By F. D. Davis and V. Venkatesh, 1996, Decision Sciences, 27(3), 451-481.

Later research determined that the general computer self-efficacy of users influences perceived ease of use of a new technology (Venkatesh & Davis, 1996). If so, professional

development for a target group to improve overall self-efficacy of computer skill may improve perceived ease of use for new technologies.

In what Venkatesh & Davis, (1996) called TAM2, they theorized that a desire to improve personal social image within a group and that experience with a technology would increase perceived usefulness. These researchers also defined "four cognitive instrumental determinants to perceived usefulness: job relevance, output quality, result demonstrability, and perceived ease of use" (Venkatesh & Davis, 2000, p. 180). Figure 4 shows the expansion of specificity of the determinants influencing perceived usefulness in TAM2.

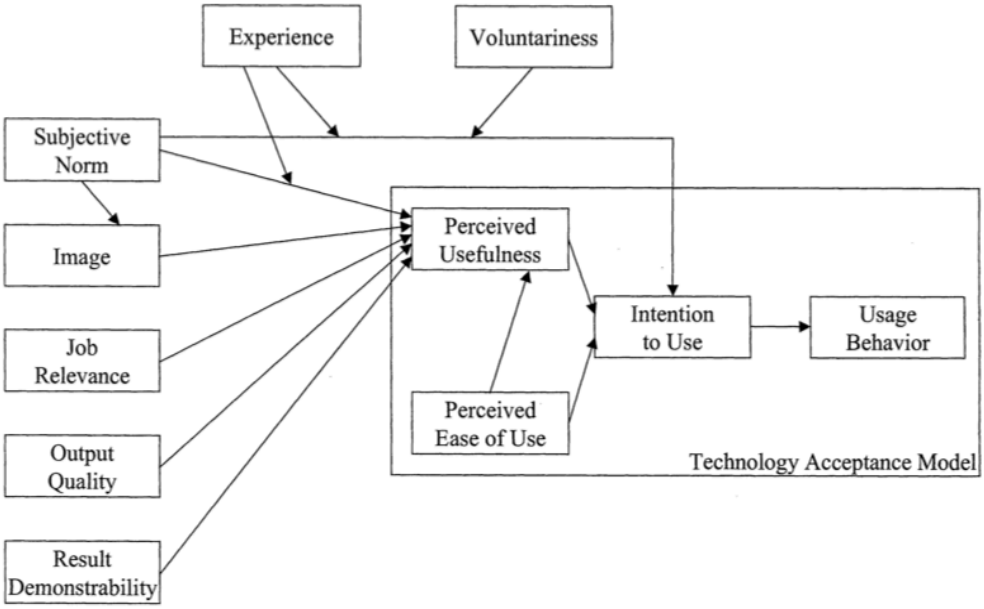


Figure 4. Technology Acceptance Model 2 (TAM2). From "A theoretical extension of the technology acceptance model: Four longitudinal field studies," by V. Venkatesh and F. D. Davis, 2000, Management Science, 46(2), 186-204.

By 2003, the TAM evolved yet again to the Unified Theory of Acceptance and Use of Technology (UTAUT), seeking to combine eight models into one theory. The UTAUT added determinants and cross-validated against the other models (Venkatesh, Morris, Gordon & Davis, 2003), including the theory of planned behavior, which accounted for teacher beliefs about technology as a determinant influencing their use (Sugar, Crawley & Fine, 2004, 2005). As shown in Figure 5, the theory of planned behavior opens the door to examining the teaching and technology practices of educators but focuses primarily on behaviors and not on attitudes. Others explored this combination of theories or used UTAUT to study self-efficacy and attitude toward using technology among older Chinese adults and in general among educators in a tablet device implementation (Pan & Jordan-Marsh, 2010; Moran, Hawkes, and El Gayar, 2010).

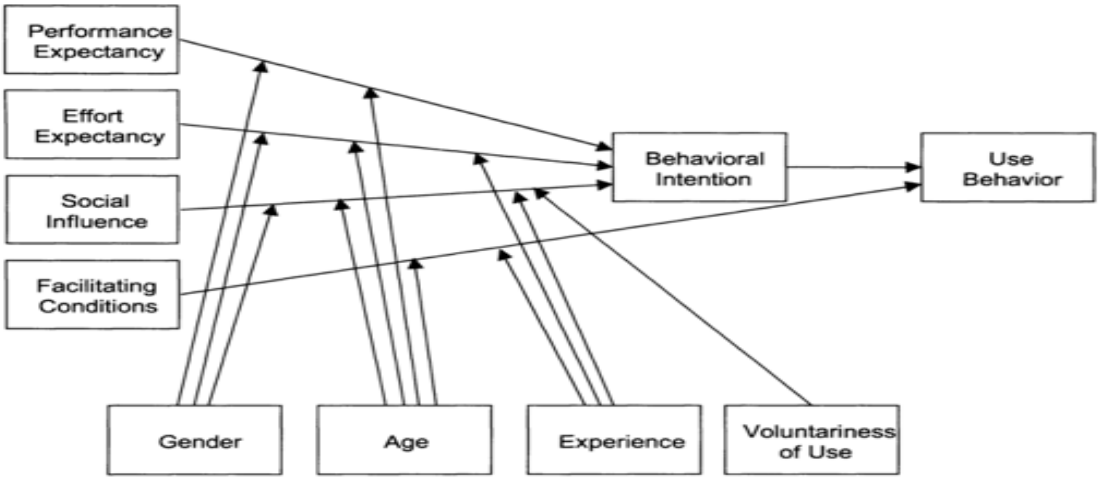


Figure 5. Unified Theory of Acceptance and Use of Technology. From "User acceptance of information technology: Toward a unified view," by V. Venkatesh, M. G. Morris, B. D. Gordon, F. D. Davis, 2003, MIS Quarterly, 27(3), 425-478.

A 2-part meta-analysis suggests that the studies using the TAM and its descendants over the years focused primarily on how perceived ease of use and perceived usefulness impacted intent to use the technology and thus, the use of the technology. What has been largely ignored, they contend, is the original TAM's inclusion of attitude towards the technology as a determinant of both intent to use and actual use (Yousafzai, Foxall & Pallister, 2006a, 2006b). Other studies confirm the importance of attitude as a determinant on the intent to use technology while ease of use may only indirectly impact intent to use through its impact on perceived usefulness (Teo & Shaik, 2012).

Venkatesh and Bala (2008) continued to refine the overall TAM model by adding three relationships, suggesting that "experience will moderate the relationships between (i) perceived ease of use and perceived usefulness; (ii) computer anxiety and perceived ease of use; and (iii) perceived ease of use and behavioral intention" (p. 281). As shown in Figure 8 the Technology Acceptance Model 3 (TAM3) contains at least 23 different determinants that influence perceived usefulness and perceived ease of use, an unwieldy but useful model.

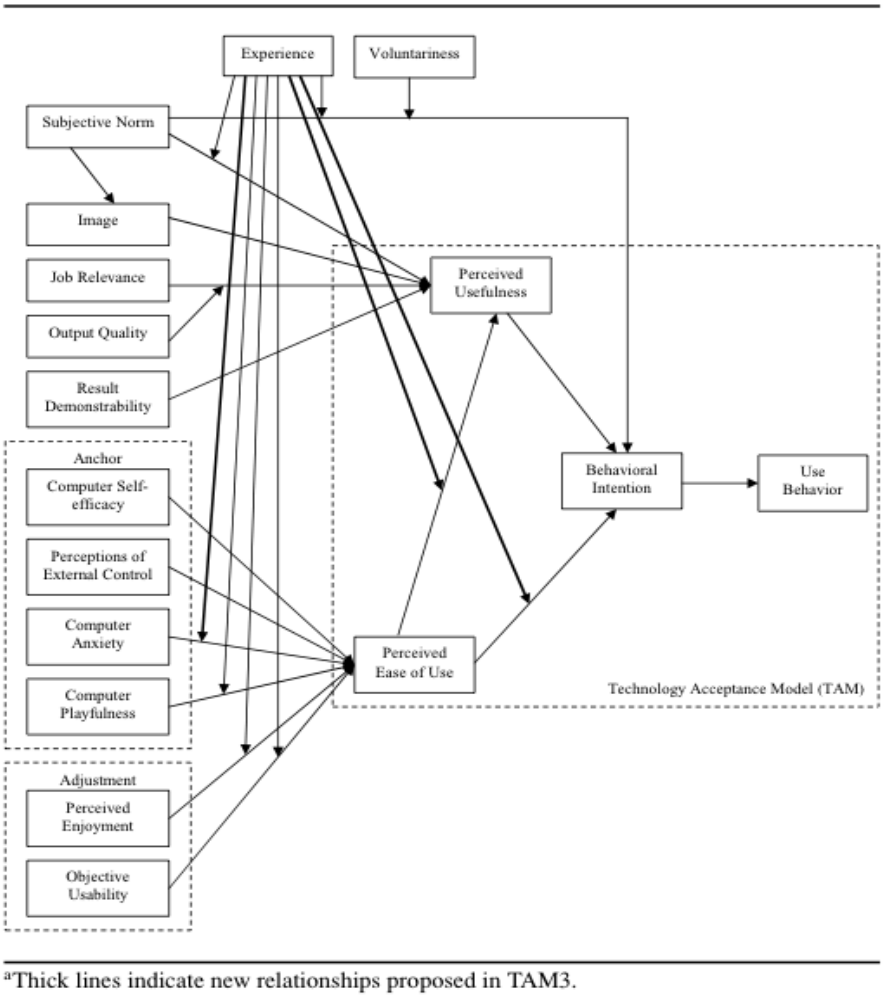


Figure 6. Technology acceptance model 3 (TAM3). From "Technology acceptance model 3 and a research agenda on interventions," by V. Venkatesh and H. Bala, 2008, Decision Sciences, 39(2), 273-315.

Overall, researchers use the TAM and its descendants, as discussed above, in a variety of studies around educator use of technology and self-efficacy towards both teaching and technology (Holden, 2011; Huntington, 2011). Others critique and add to The TAM (Bagozzi, 2007) or use the TAM in conjunction with scales and surveys developed to reveal

participant attitudes and beliefs about or barriers towards the use of technology (Chuttur, 2009; Jones, 2011). While the TAM model emerged from the information technology side, and was not specifically targeted toward education, the next model, the Apple Classrooms of Tomorrow, focused directly on how educators embrace the use of technology.

## Apple Classrooms of Tomorrow

The Apple Classrooms of Tomorrow project (ACOT), 1985-1996, constitutes one of the longest-running and broadest research efforts focused on the use of technology to support teaching and learning. The core project involved five schools of varying student demographics from across the country and 32 teachers (Sandholtz, Ringstaff & Dwyer, 1997). Eventually, the project added a focus on educator professional development and provided one-week practicums to over 600 educators. Those investigating the ACOT project involved more than 20 universities and research institutions, including sponsorship from the National Science Foundation (Sandholtz et al.).

The beginning goals of ACOT were to work with educators to implement a ubiquitous state-of-the-art computing environment at every grade level, help orchestrate positive educational development, and to understand how such an environment impacts teachers, students, and educational processes (Sandholtz, et al., 1997). The ACOT teachers collaborated in their schools and with other ACOT schools, eventually changing the management of teaching and learning to become more collaborative and student-centered (Sandholtz et al.).

Over the years the ACOT project collected a variety of data that included weekly written reports that were shared with the other ACOT schools, teacher audio tapes of

personal reflections (an average of two 60-minute tapes per month per teacher) and the observations collected by outside researchers (Sandholtz et al.). The data was put into text format, coded, and put into two relational databases that eventually grew to contain 20,000 episodes comprising approximately 5,000 single-spaced pages of text.

In 1992, six years into the project, ACOT opened teacher development centers in three of the most experienced schools to deliver professional development on how to use technology to support teaching and learning. More specifically, the ACOT teacher development centers studied how to implement high quality professional development on using technology, the impact on participating teacher attitudes towards instruction, the impact of the ACOT teacher development center process on the schools and districts, and what characteristics of the schools and districts acted as support or barriers to instructional change (Sandholtz et al., 1997). Data collection at the professional development centers included pre, post, and follow-up questionnaires, regular formal and informal interviews, weekly reports, journals, classroom observations and interviews with school leadership. Over time, extensive case studies using a variety of data sources were developed with key teachers and administrators (Sandholtz et al, 1997).

The ACOT teacher development centers served two distinct purposes: (a) the research teams collected data about what was happening to educators as they embraced the use of technology to support teaching in learning , and (b) the centers offered professional development that applied the knowledge gained through the ACOT project.

This direct connection between the use of technology to support teaching and learning, research, and professional development, although difficult to repeat as a research

process (because of the ACOT project's breath and longitudinal depth), became a model for educational institutions.

Throughout the ACOT project researchers did not want to dictate to educators a particular instructional style of using the technology so they selected more of a grounded theory approach of research-then-theory. The theoretical constructs that emerged from the research included identifying a set of stages through which teachers pass as using technology to support teaching and learning changes their beliefs about instructional practice. Through what hey labeled as the evolution of teacher thought and practice, the ACOT research team identified five stages: Entry, Adoption, Adaptation, Appropriation, and Invention. The stages identify increasingly more sophisticated uses of technology that support changes from more teacher/curriculum- centered to student-centered learning, toward more collaborative learning, and from more passive to more active learning.

At the Entry stage teachers focus more on adapting the physical devices to their classroom environment and begin to use technology for some basic tasks. During Adoption, teachers and students begin using the technology to accomplish their ongoing routine work of teaching and learning. At the Adaptation stage, teachers and students become comfortable with using technology to create, distribute, complete, and assess work; essentially the assignments are very similar to those prior to using technology with perhaps some functional improvement in efficiency and depth. At the Appropriation stage teachers begin to rethink how they structure assignments, commonly moving to project-based learning and using technology to find new ways to engage in teaching and learning. At the Invention stage teachers and students rethink the classroom environment and begin to work toward systemic

change in the classroom and school (Sandholtz et al., 1997; Dywer, Ringstaff & Sandholtz, 1990; Sandholtz and Ringstaff, 1996).

| Evolution of Teacher Thought and Practice | | |
|---|---|---|
| | Technology Use | Focus of Professional Learning |
| Entry | Physically adapting technology into class; drill-based software | Empathy |
| Adoption | Teacher Productivity; text-lecture based | How-to Skills |
| Adaptation | Student Productivity; class assignments | Classroom Management |
| Appropriation | Project-based learning; rethinking curriculum; interdisciplinary; personalized | Rethinking Curriculum; teaching practices |
| Invention | Systemic change in classroom and school | Learning Environments |

Figure 7. ACOT theoretical constructs - stages of teacher development. Based on Teaching with technology: Creating student-centered classrooms, by J. H. Sandholtz, C. Ringstaff, D. C. Dwyer, 1997, New York: Teachers College Press.

The five-stage ACOT evolution of teacher thought and practice model provides a guide for other educators as they embrace the use of technology. Applying the model to technology adoption within an institution helps teachers know how they are and should be progressing and helps administrators understand how to provide ongoing support to teachers.

Thus, the ACOT model influences technology adoption through helping educators understand the course of technology adoption and in helping administrators design professional development to support technology adoption. Figure 9 illustrates the ACOT model and its relationship to professional development (Sandholtz & Ringstaff, 1996).

The ACOT project continues to influence technology adoption on two levels. First, researchers still look to the model and directly cite its findings. Second, the ACOT project findings about educator professional development continue to influence design. The key design elements for teacher development centers include: structured observations of accomplished teacher practice, reflection on and discussion of teaching and learning, hands-on collaborative learning, and designing a curriculum project (Yocam, 1996).

ACOT researchers summarized these five lessons learned in professional development from the teacher development centers. First, teachers need support as they embrace new learning and second teachers should work in teams. Third, teachers want to use new tech skills as soon as possible and should not have to wait on equipment. Fourth, teachers value learning from each other and visiting classrooms. Lastly, even experienced teachers feel challenged by the prospect of working with other adults in a coaching capacity. Those designing professional development should focus on creating a constructivist learning environment and providing ongoing support for educators as they seek to learn how to use technology to support teaching and learning (Yocam, 1996). To summarize, "The crucial role of technology is to provide an impetus and an occasion for thinking differently about instructional practices" (David, 1996, p. 238).

The strength of the ACOT model is two-fold. The ACOT model focused specifically on education and technology and was built on a deep base of mostly qualitative research, collected at multiple sites over a period of years. The depth of the qualitative data also might be considered a weakness in the ongoing viability of the model. ACOT findings have been referenced by other researchers many times but the research methodology has not been replicated, probably because of time and resource requirements to conduct such a study would be prohibitive. Therefore, the continuing research base to test the ACOT findings is not as strong as other models. The next model, the Concerns-Based Adoption Model, focuses on education and includes a survey that has allowed it to be tested in other research models over the years.

## The Concerns-Based Adoption Model

This section includes discussion about models that combine stages of diffusion of innovation, similar to the ACOT model, including the Concerns-Based Adoption Model (CBAM), the Levels of Technology Integration (LoTi) Model, and Diffusion of Innovation Theory. While the LoTi model focuses on technology adoption, the CBAM focuses on teachers but not necessarily technology while the Diffusion of Innovation theory is the broadest model in terms of application and was not originally created for either technology or education (Blackburn, 2011).

Gene Hall developed the Concerns-Based Adoption Model that describes the concerns teachers experience in the process of adopting an innovation. The CBAM assumes that change is a process accomplished by individuals in a personal experience that involves developmental growth and is best understood in operational terms. Thus, those in position to

facilitate change should focus on individuals, innovations and context (Hall, Loucks, Rutherford & Newlove, 1975; Straub, 2009). The model includes these three components -- stages of concern, levels of use, and innovation configuration (Straub).

The CBAM identifies seven developmental stages of concern through which educators pass as they adopt new innovations: Stage 0, Awareness; Stage 1, Informational; Stage 2, Personal; Stage 3, Management; Stage 4, Consequence; Stage 5, Collaboration; Stage 6, Refocusing (Hall, Wallace, & Dossett, 1973; Hall, 1976). The CBAM also identifies levels of use of an innovation: Level 0, Non-use; Level I, Orientation; Level II, Preparation; Level III, Mechanical Use; Level IV-A, Routine Use; Level IV-B, Refinement; Level V, Integration; Level VI, Renewal. The authors also defined the levels in terms of seven categories: knowledge, acquiring information, sharing, assessing, planning status reporting, and performing (Hall, et al., 1975)

Researchers apply CBAM to a variety of study topics related to educator technology adoption, including teacher preparation programs (Brzycki & Dudt, 2005) and a variety of study methodologies and variables, age and gender (Overbaugh & Lu, 2009). Some researchers compare the CBAM and ACOT models. Hall, Chamblee, and Slough (2011) developed a model to explore the levels of use of electronic whiteboards where levels 0-2 of the CBAM equaled the entry level of the ACOT model and all other levels were comparable. In an effort to find a way to measure technology adoption levels against student achievement, Hancock, Knezek, and Christensen (2007) cross-validated the CBAM and the ACOT models with their own model, Stages of Adoption of Technology.

Some use the CBAM to focus on the effectiveness of professional development regarding a technology implementation. Towndrow and Wan (2012) used the CBAM to develop profiles that described a continuum of increasing and decreasing pedagogical and operational capabilities for high school teachers in a one-laptop-to-a-student technological environment and suggested methods of professional development. Overbaugh and Lu (2009) also used the CBAM to measure levels of teacher concern about a technology implementation funded by a NCLB grant in a pre-post survey format, finding that professional development may have helped to reduce the levels of self-concern.

In 1995, Chris Moersch published the Levels of Technology Integration (LoTi), a model to determine levels of technology integration. The model describes six steps through which educators pass as they learn to use technology in the teaching and learning process. According to Moersch (2010),

The original LoTi framework was the by-product of two separate initiatives: David Dwyer's research with Apple Classrooms of Tomorrow (ACOT) and the Concerns-Based Adoption Model (CBAM). ACOT's research provided the theoretical inspiration for the model, and CBAM outlined the changing behaviors and concerns that educators experience as they integrate innovations into their classrooms. (p. 20)

Moersch's model includes a survey that determines the levels of technology integration. Over the years the Levels of Technology Integration became the Levels of Teaching Innovation as the model expanded to describe teaching practice instead of just technology integration. The levels in the model are: Level 0 - Non-use, Level 1 - Awareness, Level 2 - Exploration, Level 3 - Infusion, Level 4a - Integration (mechanical), Level 4b -

Integration (routine), Level 5 - Expansion, and Level 6 - Refinement (Moersch, 2010). This empirically validated model had been used in more than 60 doctoral dissertations as of 2010 as well as published studies (e.g.m Rakes, Fields & Cox, 2006; Barron, Kemker, Harmes & Kalaydjian, 2003). Using the LoTi survey to conduct pre-post style studies provides insight as to the progression of technology adoption and the movement toward more student-centered learning as described by the ACOT research.

Other models emerged, including the Kotrlik-Redmann Technology Integration Model, which uses four steps to describe the levels of technology integration, Exploration, Experimentation, Adoption, and Advanced Integration. This model, based in part on the ACOT research (Jones, 2011), includes three scales: (a) the Technology Adoption Scale, (b) the Barriers to Technology Integration Scale, and (c) the Technology Anxiety Scale, all with exemplary reliability (Redmann & Kotrlik, 2008).

## Diffusion of Innovations Theory

The Diffusion of Innovations Theory, developed by Everett Rogers, is widely used across a variety of fields (e.g., science, technology, history, and economics) to understand individual adoption and collective diffusion patterns (Sahin, 2006; Straub, 2009). Rogers believed that the decision to adopt an innovation was a social process that unfolds across five stages: knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). These stages align with the stages of the ACOT model and those of the CBAM.

Rogers considered time to be an important, but rather neglected component of the diffusion adoption process. Time becomes a key element in how Rogers described the adopter categories, for each of the five adopter categories takes increasingly longer to adopt

an innovation. The five categories are innovators, early adopters, early majority, late majority, and laggards. The relative numbers at each category within an organization form a standard curve of distribution. Therefore, for example, innovators make up the smallest percentage of population in an organization, approximately 2.5%, and adopt a new innovation most quickly while the early and late majorities comprise 34% each of the population and take longer to adopt (Blackburn, 2011; Rogers, 2003; Straub, 2009).

One reason that Rogers' theory of innovation diffusion has been so widely used is that it may be applied broadly or in more specific instances to understand how people experience adoption of an innovation. In fact, some of the research used by Rogers came from agriculture and consumer science (Rogers, 2003). This helps make the model applicable at the institutional level and more applicable at the individual level (Blackburn, 2011; MacVaugh & Schiavone, 2010).

### Technology Adoption Models Summary

The general types of technology adoption models, the TAM, ACOT, CBAM, and Diffusion of Innovation Theory discussed in this section differ slightly in their approaches. The TAM focuses primarily on technology adoption, but not necessarily on education. The ACOT model focuses specifically on technology and education. The CBAM focuses on education; researchers brought in technology later. Lastly, diffusion of innovation focuses on innovation adoption, but not specifically on technology or education.

The research models developed by Fred Davis and Viswanath Vinkatesh on the TAM, Everett Rogers on Diffusion of Innovation, David Dwyer on the ACOT model, and Gene Hall on the CBAM continue to influence conventional thinking on educational

technology adoption. A quick check of Google Scholar October 29, 2012 showed the first four articles regarding TAM that Davis either authored or co-authored have been cited over 30,000 times. Secondly, Rogers's book, *Diffusion of Innovation* has been cited over 40,000 times. One must consider, however, that Rogers did not necessarily intend for his work to describe educational technology adoption while the other models either focus on technology (TAM), education (CBAM), or both (ACOT). Hall's work on CBAM was cited over 4,000 times on the first page of a Google search. While the number of citations is lower, the first page of Google citations of Dwyer on the ACOT project (if one includes his co-authored works) goes over 3,000 citations. Dwyer worked in collaboration with others, too, perhaps most notably Judith Sandholtz.

Koehler and Mishra (2008) conceptualized the challenge of technology adoption in education as "teaching is viewed as a highly complicated form of problem-seeking and problems-solving that derives from flexible and integrated bases of knowledge" (p. 3). They identified three areas of knowledge, technology, pedagogy, and content, which teachers weave together to "produce the type of flexible knowledge needed to successfully integrate technology into the classroom" (p. 3). The TPACK model, as it is known, focuses on the synergy and interaction of technology, pedagogy and content knowledge (Doering, Veletsianos, Scharber, & Miller, 2009).

Professional development can be designed to help educators improve knowledge in three areas of technology, content, and pedagogy. Perhaps a better way to think about the professional development and the result of the learning would be to make less distinction about the three domains of TPACK and focus more on the intersections of the domains that

combine technology, content and pedagogy together (Doering, et al., 2009). The knowledge a teacher uses is more important than the knowledge a teacher possesses, the authors suggest, and the knowledge that a teacher uses depends on the context of the teaching and learning situation. With this in mind teachers may provide varying emphasis on technology, content and pedagogy, depending on the circumstances. Using the TPACK framework makes this give-and-take process on weighting the emphasis on technology, content, and pedagogy easy for teachers to understand and apply (Doering, et al., 2009; Koehler & Mishra, 2008)).

Examining technology adoption models helps inform a methodology for using theory-building research techniques to combine technology adoption models with adult learning theory to generate new theory about the way that educators adopt technology to support teaching and learning. Some studies use or discuss more than one model and build alignment across the models (Hancock, Knezek, & Christensen, 2007; Hixon & Buckenmeyer, 2009; Jones, 2011; Moersch, 2010; Straub, 2009; Toledo, 2005). The idea that the models may work together could allow for building a theory into which a variety of technology adoption models could be inserted.

The technology adoption models, as applied to education technology adoption, essentially describe how educators experience change and embrace innovation. A missing ingredient in this process is that adult learning theory is not specifically utilized to help both those experiencing the change and adopting the innovation as well as those who facilitate the process either as leaders or professional developers. Once the adult learning theory elements get added, a variety of technology adoption models might be suitable as both an

organizational model and as an explanatory or research model. The next section of the review of literature examines the adult learning theory, andragogy.

## Adult Learning Theory

### What is Andragogy?

Malcolm Knowles changed the world of adult learning in 1973 when he published The Adult Learner: A Neglected Species. Knowles identified four assumptions about andragogy that differ from pedagogy: (a) changes in self-concept, (b) the role of experience, (c) readiness to learn, and (d) orientation to learn (Knowles, 1973). He later added these additional assumptions that (e) adult learners benefit when they find an internal motivation to learn, and that (f) adults should, if possible, enter into learning on a voluntary basis because of a critical need to know (Knowles, 1980b; Knowles, Holton & Swanson, 1998). These assumptions about the uniqueness of the adult learner form the heart of andragogy as defined by Knowles. Knowles first called andragogy a theory of adult learning. As discussion ensued among scholars about andragogy Knowles and others began to refer to andragogy less as a theory, and more as a model. Knowles referred to andragogy as a set of assumptions about adult learners. Discussion ensued about whether or not andragogy was a theory and/or deserved to be thought of as the theory. In the 1984 edition of The Adult Learner Knowles added seven process design elements: (a) Setting an appropriate climate, (b) mutual planning involving the learner, (c) learners diagnose their learning needs, (d) learners help set learning objectives, (d) learners help design learning plans (e) supporting the implementation of learning plans, and (f) Involving learners in evaluating their learning (Knowles, 1984).

The Adult Learner was built on a 1970 publication by Knowles in which he began to use the term andragogy. Knowles used the term andragogy which he defined as the "art and science of helping adults learn" (Knowles, 1970), to distinguish his theory from pedagogy which he defined as teaching children and youth. Drawing a sharp line between pedagogy, teaching children, and andragogy, helping adults learn, Knowles also provided environmental and organizational ideas for adult learning situations and advice for adult facilitators (Knowles 1970).

In writing about the theory of andragogy Knowles drew on his own work as well as the work of others. His chapter on the historical development of adult education in the 1960 Handbook for Adult Education in the United States clearly established his broad field of view across the adult learning landscape. In his survey of learning theory, Knowles divided theorists into propounders and interpreters, and their models of learning into mechanistic models in which learning may be programmed (behaviorist) and organismic models in which humans seek self-actualization through continuous improvement (humanist). Drawing together the ideas of Bruner, Dewey, Maslow, Piaget, Rogers, Skinner, Thorndike, Watson, and many others, Knowles discusses strengths and criticisms. Next, Knowles moves to discussion about theorists who work primarily with adults, such as Freud and Rogers, then on to adult learning theorists such as Tough and Houle. Knowles cycles back through these theorists as he discusses theories about teaching as they relate first to children, then adults.

In the process of introducing his theory, andragogy, Knowles reviews the European roots of the use of the term andragogy to distinguish adult learning and credits (Lindeman, 1926; see also Brookfield, 1984, for Lindeman's influence on andragogy) for identifying the

conditions of adult learners that become the core of his theory of andragogy. Knowles clearly delineates a need for a separate way to view adult learners, referring to the term "the millstone of pedagogy" (Knowles, 1973, p. 42) as an apt symbol of an increasingly repressive educational system that continuously seeks to pedagogically program teachers and learners.

| **Assumption or Principle** | **Andragogical Approach to Learning** |
|---|---|
| Increasingly self-directed | Increasingly self-directed |
| Readiness to learn | Develops from life tasks and problems |
| Experience | A rich resource for learning by self and others |
| Orientation | Task or problem-centered |
| Motivation | Internal incentives, curiosity |
| Need to know | Learner's perception of what and why of learning important to overall learning experience |

Figure 8. Six principles or assumptions of andragogy. From The adult learner. The definitive classic in adult education and human resource development, by M. S. Knowles, E. F. Holton, III and R. A. Swanson, 2005, (6th ed.), Burlington, MA: Elsevier.

| Process Design Element | Andragogical Approach to Learning |
|---|---|
| Preparing the learner | Supply information, prepare students for participation, develop realistic expectations, begin thinking about content |
| Climate | Relaxed, trusting, mutually respectful, informal, collaborative, supportive |
| Planning | Mutually by learners and facilitator |
| Diagnosis of needs | By mutual assessment |
| Setting of objectives | By mutual negotiation |
| Designing learning plans | Learning contracts, learning projects, sequenced by readiness |
| Learning activities | Inquiry projects, independent study, experiential techniques |
| Evaluation | By learner-collected evidence validated by peers, facilitator, experts, criterion-referenced |

Figure 9. Eight process design elements of andragogy. Based on "Toward development of a generalized instrument to measure andragogy," by E. F. Holton III, L. S. Wilson, and R. A. Bates, 2009, Human Resource Development Quarterly, 20(2), 169-193.

The 6 principles and 8 process design elements from Figures 8 and 9 provide a set of essential conditions for adult learning that could contribute to a model for analyzing educator professional development.

A quick check of Google Scholar on February 25, 2011 revealed that the first (1973) third (1984) and fifth (1998) editions of The Adult Learner alone have been cited in other publications over 5,000 times and that, therefore, Knowles' work remains relevant into the 21st century. The depth and breadth into which Knowles took his development of the theory of andragogy contributed to the wide discourse about the theory that ensued. Perhaps a second reason that Knowles' work became so important was that the field of adult education had grown tremendously in the years after WWII (Swanson and Holton, 2009) and a theory of adult learning served to further delineate and distinguish the field. The Adult Learner is in

its sixth edition, having been passed to co-authors Holton and Swanson after the death of Knowles in 1997.

In line with his theory Knowles presented practical solutions to approaching adult learning, including providing insight about the conditions of adult learning, frequently focusing on the field of Human Resource Development (HRD). A good example might be the monthly column he provided for the Training and Development Journal from September 1979 - August 1980 in which he wrote about topics such as dealing with fads in training, how instructors can implement self-directed learning, and the history of training as it relates to understanding current trends (Knowles, 1979a; Knowles, 1979b; Knowles, 1980a). Knowles also used his column to address the critiques of andragogy, for example, explaining the relationship between andragogy and pedagogy.

> The andragogical model does not replace the pedagogical model; it provides an alternative set of assumptions. So now we have a system of assumptions that includes both sets. And thus leads us to the critical difference between the two models. The pedagogical model is an ideological model that excludes the andragogical assumptions. The andragogical model is a system of assumptions that includes the pedagogical assumptions (Knowles, 1980b).

In other publications Knowles discussed such things as how to maximize adult learning when serving as a conference presenter (1992) or his own endeavors to learn to use a computer (1983) as well as advice on how to design class activities to help adults embrace self directed learning (Hatcher, 1997), or tips on facilitating adult learning. As these cases

reveal Knowles was practical in his application of andragogy to life situations and down to earth in his approach to supporting adult learners.

By the 1980s Knowles added detail to techniques for supporting adult learners in the transition to become self-directed learners, including his work on learning contracts (Knowles, 1984, 1987). The learning contract provided a practical tool for facilitators as they moved both themselves and the adult learners with whom they worked through what could become a difficult transition to self-directed learning. Making learners more responsible for their learning necessitated changing the role of the teacher.. Knowles continued to think and write about andragogy throughout his life, publishing articles and revised editions of The Adult Learner.

## Criticism of Andragogy

Criticism of andragogy seems to divide into three categories. Some argue that empirical research studies provide inconsistent results in terms of the efficacy of andragogy. An non-researchable theory or model is no model or theory at all, some might argue. Others contend that andragogy does not account for the context of the learning, such as who is the learner, and what are the circumstances under which the learning occurs. Still others believe that andragogy does not adequately promote social justice and that, rather, andragogy reinforces the status quo in educational structures.

Rachal (2002) conducted a meta-study of empirical research on andragogy and determined that the studies returned uneven results because the principles of andragogy may have been implemented unevenly. Andragogy deserves better, Rachal laments:

The most persistent and best-known theoretical construct of the field of adult education over the last three decades should be more than a beloved article of faith underlying much present practice. It should move beyond anecdote and scattershot definitions implemented in apples-and-oranges empirical studies. What is required is a more operational, criteria-based definition—such as that offered here but in any case closely following the precepts and ideals of Knowles—to which future researchers might assent in conceiving and designing their investigations. (Rachal, 2002, p. 225)

In an attempt to establish common ground for future empirical research Rachal offers the seven research design principles for andragogy.. These empirical research design principles include: (a) Voluntary participation, (b) Adult status, (c) Collaboratively determined objectives, (d) Performance-based assessment of achievement, (e) Measuring satisfaction, (f) Appropriate adult learning environment, and (g) technical issues. Rachal's work contributes to the field in two ways: 1) it provides useful tables for comparing and contrasting empirical studies on andragogy and 2) it makes useful suggestions for future empirical research involving andragogy.

A few years later, Holton, Wilson, and Bates (2009) agreed with Rachal about the general lack of quality empirical research on andragogy. They reported success in creating an inventory, The Andragogical Practices Inventory, (API) to measure "an instructor's andragogical behaviors on the basis of andragogy's six principles and the eight process design elements (Holton, Wilson & Bates, 2009, p. 173). The API shows promise for future research on andragogy.

A second area of criticism about andragogy concerns the context of the learner and the learning environment. St. Clair (2002) and Clardy (2005), for example, take issue with Knowles' use of the terms pedagogy and andragogy or, more specifically, how Knowles defines a child learner and an adult learner and uses those definitions to distinguish adult learning. They assert andragogy does not account for differences among adult learners or for adult learning situations. One should note that Knowles' own opinion about this changed, even to the point of changing the subtitle of the second edition of his 1970 publication from andragogy versus pedagogy to andragogy and pedagogy. St. Clair and Clardy continued their argument, determining that as the distinction between an adult learner and a child learner becomes less concrete, so then does the claim of andragogy as a unique learning model for adults. Illeris (2003) and Jarvis (2007) both argue that andragogy does not adequately address the social context of the learner.

Holton, Swanson, and Naquin (2001) had addressed contextual differences and used a model called Andragogy in Practice, published in the fifth edition of The Adult Learner (Knowles, Holton & Swanson, 1998) to clarify their position. The model overlays andragogical assumptions and design elements with individual and societal growth, situational and subject matter differences. They wrote "Andragogy is a transactional model of adult learning that is designed to transcend specific applications and situations" (Holton, Swanson & Naquin, 2001, p. 125). They concluded that efforts to embed in andragogy the purposes of other areas of study are "conceptually and philosophically flawed" (p.125).

A final area of criticism of andragogy as the theory of adult education concerns critical theorists and social justice. By the 1990s researchers in adult education such as

Sharon Merriam began taking a look back at the landscape of adult learning in the context of the influence of Knowles and andragogy (Merriam, 1993), a process that continues in the 2000s. Pratt's (1993) chapter contribution to Merriam's 1993 work on adult learning theory, appropriately entitled "Andragogy After Twenty-five Years" provided an excellent summary of Knowles' work on andragogy and related critiques and contributions. Pratt asked four key questions: (a) What is Learning? (b) What are the antecedents to adult learning? (c) How can we facilitate adult learning? (d) What are the aims of adult learning?

In addressing these questions Pratt weaves together Knowles, andragogy, and emerging themes in adult learning theory. Pratt points out that, by using Lindeman and others Knowles helped move the discussion about what is learning from a behaviorist to a constructivist perspective, a dramatic shift that continues to influence adult learning (Pratt, 1993).

Regarding the antecedents of adult learning, Pratt maintains that Knowles and andragogy established the capacity of adults to be self-directed learners and that adult learners should be respected for their individual uniqueness. Pratt suggests also that others, led by Freire and critical theorists established that "learning and cognition are fundamentally situated within, and related to, social and historical contexts. (p. 18)." Pratt, thus, recognizes the importance of a wide range of possibilities in adult learning that include race, gender, and social-economic status. This focus on learning context addresses a key area of criticism of Knowles and andragogy.

Regarding the facilitating of adult learning Pratt lists Knowles' seven design elements of andragogy, an area that Pratt suggests may be underutilized. While Pratt agrees about the

importance of the design elements he focuses on the importance of the facilitator recognizing individualism of the learner and stressing andsupporting the freedom from control of the learner. This is a nod to the critical theorists and supporters of learning as emancipatory, such as Freire (2000), again addressing an area of criticism of andragogy (Pratt, 1993). Pratt concludes that andragogy proves valuable in understanding the nature of, and needs of adult learners, but that it may not explain learning. The debate on the nature of learning may be embedded in discussions that contrast the psychological versus the social, and freedom versus authority. Those who demand solid empirical research on adult learning theory (another criticism of andragogy), insists Pratt, must first account for this debate about the nature of learning.

Sandlin (2005) provides a more detailed example of the criticism of andragogy from the critical or social justice perspective, summarizing the issue thusly:

The critical perspective, in both its Habermasian and Freireian manifestations, highlights power dynamics, questions the technical rationality of educational practice, and sees social change as the goal of education. Critical educators show how mainstream, andragogy-based adult education helps to reproduce inequalities through universalizing certain assumptions, decontextualizing learning, and focusing on technical knowledge (Sandlin, p.38).

Sandlin concludes that andragogy certainly provides an important framework for adult learning but that it does not adequately address questions of power, who controls the learning process, what the purpose of adult learning should be, and who should benefit from adult learning (Sandlin, 2005). Brown (2006) seeks to account for the questions around

critical theory to find a transformative andragogy that addresses the needs of educational leaders looking for learning models that address social justice and equity.

In a 2-part article that links adult education to HRD, Hatcher and Bowles (2006a, 2006b) provide a perspective of the role played by andragogy in adult education. Seeking to find common ground that may build a bridge between HRD and adult education, they explain the impact of critical theory on each area as having a much greater impact on adult education andmuch less impact on HRD. They submit, going forward critical theory could be the connecting link between adult education and HRD. In the process of providing the background of adult education Hatcher and Bowles note that "in an effort to build a professional brand and identity for the field of AE, Knowles's andragogy emerged as a prevailing discourse beginning in the late 1960s and early 1970s that held sway for nearly two decades" (Hatcher & Bowles, 2006b, p. 7). They add the discourse in adult education shifted toward critical perspectives by the early 1990sled in part by Mezirow's transformational learning (Hatcher & Bowles, 2006b; Mezirow, 1991).

**Some Uses of Andragogy**

Technological innovations render new styles of communication, collaboration, and access to information, all especially significant to adult learning. Several studies seek to apply andragogical concepts to online learning (Cercone, 2008; Colton & Hatcher, 2004; Hatcher & Colton, 2007; Donovant, 2009; Hurt, 2007). Cercone addresses the use of andragogy in online adult learning environments and reviews other learning theories, self-directed, experiential (both of which have roots in andragogy) and transformational learning (Cecone, 2008). Hatcher and Colton developed an instrument to measure the use of

andragogy in a mediated online learning environment using Delphi processes. They concluded that part of the meaningful outcome of their work was to bring andragogy in to the 21st century (Colton & Hatcher, 2004; Hatcher & Colton, 2007). In a study of the impact of online learning for police officers Donavant (2009) addresses the andragogical notion that learners progress from pedagogical perspectives to andragogical perspectives as they mature as learners. Donavant concludes that in online learning for adult learners pedagogical approaches work best in many instances while andragogical approaches work better in others.

Indeed, the andragoginess of professional development training may well depend on the voluntariness of the experience, a measure often assessed in light of the self-directedness of the adult learner, that is, the willingness to participate relative to one's life experience and adult role (Donavant, p. 242).

In this sense andragogy makes contributions to online learning. Knowles, of course, would have insisted that the pedagogical and andragogical approaches should be implemented together and apart as appropriate. Hurt (2007) seeks to apply andragogy to providing online support to adult learners who are learning software, combining it with situated cognition and minimalist training as opposed to constant instructor-led training.

At times it appears as if researchers in other fields discover andragogy and, because of its immediate usefulness and clarity, suddenly embrace it as a necessary practice in their field or, at the very least, as a useful way to frame discussion. Patterson (1986) wrote about the connection between creative people and andragogical learners. Forrest and Peterson (2006) write about the usefulness of andragogy in management education. They encourage

their colleagues to drop the term pedagogy and embrace the more useful and appropriate adult learning term, andragogy, Even the title of their article, It's Called Andragogy, indicates that they are at the beginning of exploring the world of adult education and the impact of andragogy. Hines (2006) uses andragogy to frame self-awareness and self-directed learning among prospective school administrators. Bolton (2006) and Donavant (2009) use andragogy in rubrics to help adult learners understand learning objectives more clearly. Zmeyov (1998) discusses andragogy in the context of Russia's new free market system, and the responses (and needed changes) from education. Zmeyov includes a brief overview of how andragogy (including its antecedents such as Dewey and Lindeman) and Russian theorists influenced current Russian thought. This researcher finds this an interesting view of how a theoretical model around adult learning might be constructed in a different country. Of course, with over 5,000 Google Scholar citations the list of uses of andragogy could go on and on. The point is andragogy's influence spreads far and wide.

## Summary of Examination of Andragogy

Moving forward leaders in the field of andragogy such as Merriam, Holton, Rachal and Hatcher seem to have found a place for andragogy. Andragogy may not be the theory of adult education. It might be a model that is sufficient in some cases, and works in tandem in some cases with other areas of related thought and practice such as self-directed learning, learning through life experiences and critical voices. Andragogy absolutely continues to influence thought and practice in adult learning. Additionally, recent efforts may prove to provide a foundation for future empirical research on the efficacy of andragogy. Certainly as the field of adult education moves forward, the assumptions and design elements of

andragogy will be viewed through new lenses such as the learning context, multidimensional approaches, emerging brain research, and non-western philosophical approaches (Merriam, 2008). The next section of the review of literature examines the adult learning theory, transformative learning.

## Adult Learning Theory: Mezirow

> Jack Mezirow has led the writing about transformative learning. Mezirow explains: Transformative learning is the process of effecting change in a *frame of reference.* Adults have acquired a coherent body of experience – associations, concepts, values, feelings, conditioned responses – frames of reference that define their life world. Frames of reference are the structures of assumptions through which we understand our experiences. (Mezirow, 1997, p. 5)

Frames of reference consist of two dimensions, habits of mind and points of view. Habits of mind are broader, more ingrained, habitual and influenced by assumptions. Points of view are the articulation of a habit of mind. For example, a habit of mind might be that the teacher should teach and the learner should learn. Points of view might be the way a lesson gets structured, with objectives defined by the teacher, content taught by the teacher and learned by the student quietly on task in a classroom. Points of view are easier to change. We do this constantly based on how well things work. We may test another's point of view and adapt it as our own (Mezirow, 1997).

Mezirow defines four processes of learning. First, we elaborate on an existing point of view. Second, we establish new points of view. Third, we transform a point of view. Last,

we transform a habit of mind. This fourth step happens much less frequently and will not occur as long what we learn fits into our existing frames of reference (Mezirow, 1997).

Mezirow goes on to discuss the need for adults to function as autonomous thinkers and for adult educators to create opportunities that engage adult learners in self-reflection through instrumental and communicative learning processes that lead to autonomous thinking. He equates autonomous thinking with the ability to, "become critically reflective of one's own assumptions and to engage effectively in discourse to validate one's beliefs …" (Mezirow, 1997, p. 9). The foundations necessary for adults to function as autonomous thinkers extends beyond the foundations needed for children to think autonomously. Figure 10 outlines how Mezirow's foundations for adults build on the foundations for children.

| Foundations for Children | Additional Foundations for Adults |
|---|---|
| - Recognize cause-effect relationships<br>- Use logic to make analogies and generalizations<br>- Control one's emotions<br>- Empathize with others<br>- Use imagination to construct narratives<br>- Think abstractly<br>- Think hypothetically<br>- Become critically reflective of what one thinks, sees, and hears | - Become critical in assessing assumptions of others and of one's own beliefs, values, judgments, and feelings<br>- Recognize frames of reference and imagine alternatives<br>- Work with others to assess reasons, pose and solve problems, and arrive at a tentative best judgment regarding contested beliefs |

Figure 10. Mezirow's learning foundations necessary for autonomous thinking. Based on "Transformative Learning: Theory to Practice," by Jack Mezirow, 1997, *New Directions for Adult & Continuing Education*, 74(5).

Figure 10 could form the basis for part of a conceptual framework to examine the design of professional development for educators. Rightly so, educators focus on standards, outcomes, and strategies that may promote improvements in student achievement. Those who

design professional learning experiences for educators also tend to focus on helping educators learn strategies that work in the classroom. Mezirow's foundations for children form a solid framework to support this design. However, professional learning designers should also focus on Mezirow's foundations for adults. Analyzing professional development activities and strategies against this framework may be one way to determine if participants are being guided to become autonomous thinkers who can transform their teaching and learning practice.

Adult educators must be aware that for adult learners to become autonomous thinkers they need to extend beyond the learning foundations of child learners. "Transforming frames of reference through critical reflection of assumptions, [and] validating contested beliefs through discourse," (Mezirow, p. 11), the heart of Mezirow's Transformation Theory, provides a strong framework for adult learners. The question is, should educators address the additional foundations necessary for adults to be autonomous thinkers in educator professional development design? Cranton and King believe the answer is yes. They write:

Effective professional development brings our habits of mind about teaching into consciousness and allows us to examine critically what we believe and value in our work as educators. The goal is to open up alternatives, introduce new ways of thinking about teaching—a goal that is potentially transformative. (Cranton & King, 2003, p. 34).

## Combining Andragogy and Transformative Learning

The assumptions and design elements from andragogy and the foundations necessary for autonomous thinking from Mezirow combine to provide a broad framework from which to investigate professional development for K-12 educators. John Rachal conducted a study

focused on developing an empirically operational definition of andragogy, that is, a definition that creates a researchable framework. His meta-analysis of empirical research on andragogy resulted in the development of seven criteria of andragogy. The seventh criteria, logistics, concerns research issues such as population, experimental design and so forth, and does not apply to the actual definition of andragogy, leaving the first six criteria as a good empirically operational definition of andragogy. Rachal's criteria, adult status, voluntary participation, collaboratively-determined objectives, performance-based assessment of achievement, and appropriate adult learning environment, combine the six assumptions and eight design elements of andragogy (Rachal, 2002). These criteria and Mezirow's adult foundations for autonomous thinking influence Figure 11 to describe the conditions of andragogy and the processes of transformative learning. This model, the conditions and processes of adult learning, will be used in this response to analyze documents from NSDC, ISTE, and P21 for elements of adult learning.

| Conditions | Processes |
|---|---|
| **Environment**<br>Relaxed, casual, trusting, collaborative, supportive | |
| **Status**<br>Increasingly self-directed; use life experiences as a base for learning | |
| **Readiness**<br>Internally motivated; focus on solving authentic problems; clearly understood reasons to learn | |
| **Planning**<br>Collaborative needs assessment, agreed upon objectives, and planning for learning; learning contracts | **Critical Reflection**<br>Become critical in assessing assumptions of others and of one's own beliefs, values, judgments, and feelings |
| **Performance**<br>Performance-based learning activities, collaboratively supported | **Working with Frames of Reference**<br>Recognize frames of reference and imagine alternatives<br><br>**Dialoging to Re-frame**<br>Work with others to assess reasons, pose and solve problems, and reach solutions regarding contested points of view |
| **Reflection**<br>Self-reflection; additional evidence collected from and validated by peers, facilitator, and others | |

Figure 11. The conditions and processes of adult learning. Based on "Transformative learning: Theory to practice," by Jack Mezirow, 1997, New Directions for Adult & Continuing Education, 74(5), and The adult learner. The definitive classic in adult education and human resource development, by M. S. Knowles, E. F. Holton, III and R. A. Swanson, 2005, (6th ed.), Burlington, MA: Elsevier.

One way to read Figure 11 is in chronological order, that is, as a set of conditions and processes that may easily read from top to bottom in terms of logical steps that lead one to another. Establishing an appropriate adult learning environment, helping the learners understand "adult status," and ensuring that the learners are ready to learn may be a good starting point. Once in place, these conditions lead naturally to planning, implementation

(performance), and reflection. The processes of critical reflection, working with frames of reference, and engaging in dialogue to adjust frames of reference also seem to fit together as a series of steps.

Viewing the table this way should not preclude viewing the conditions outside of a set sequence. Certainly the conditions of environment and status are not time bound. Reflection as a condition should be distinguished from critical reflection as a process. Knowles et al. refer to evaluating learner satisfaction through self-reflection validated by peers, experts and other sources (1998). Mezirow (1997) refers to critical reflection as the process of critically assessing the values, beliefs, judgments, and feelings of oneself and others.

Others have combined Knowles' andragogy and Mezirow's transformative learning to create models for thinking about adult learning. Brown (2006) combined andragogy, transformative learning and critical social theory to create a model that supports the preparation of educational leaders who address social justice and equity. Kiely, Sandmann, and Truluck (2004) describe a four-lens model for adult learning, (learner, process, educator, and context) to address andragogy (learner), transformative learning (process), and critical social theory (context). In a meta-analysis of studies about the use of Mezirow's transformative learning theory as a tool for measuring transformative process, Snyder (2008) points out two areas that would strengthen the research, triangulation of the data (beyond self-reflection by participants) and making the studies more longitudinal. Combining the transformative learning process with the steps of andragogy that may be managed by an instructor could help with the triangulation of data.

## Theory and Theory-Building Research

To introduce the first issue the *Human Resources Development Review* (HRDR), a journal founded to be the premier outlet and advocate for theory and theory building in human resource development (HRD), the editor, E. L. Holton III, wrote an essay that addressed the need for and the reason to study theory building research (2002). Referencing Dubin (1969), Cohen (1989), and Kaplan (1964), Holton first addresses why scholars should study theory. Theory is important, Holton says, because theory helps humans explain things in the world, theory comprises an important part of science without which science might merely be a body of facts, and theory helps make predictions based on our experiences in life. Recognizing the importance of theory leads one to understand that for the study of HRD to continue to grow, the field needs more research in the area of theory and theory building (Holton 2002). Holton believes that HRD applied research should embrace theory building as equally as it embraces application research (2002).

Toracco (1997) provides seven roles for theory in HRD research, including interpreting data, responding to new problems, defining problems, evaluating solutions, discerning priorities in knowledge, reinterpreting old data, and identifying new directions for research. Holton adds to Torraco's list that "most sophisticated quantitative statistical techniques (e.g., structural equation modeling) demand robust theory to even be used" (Holton, 2002, p. 5).

To address the myth that theory is not useful for practice Holton recalls perhaps the most famous line about theory in research when Kurt Lewin (1951) gave us, "There is

nothing so practical as good theory" (Holton, 2002, p. 5). Holton goes on to provide five ways that theory improves practice.

- Good theory leads to better research that in turn can lead to better practice.
- New theory is needed to create new practices.
- Theory makes the world simpler.
- Theory is the best was to deal with new situations in practice.
- Practitioners create and use new theory every day (Holton, 2002, p. 5-6)

This section addresses theory-building research in human resource development (HRD). Following a brief introduction to theory and theory building, the second part describes two models for theory building, one each from Robert Dubin and Susan Lynham. The third part provides examples of quantitative and qualitative research techniques that could be used to support theory building research. The fourth part examines in greater detail how one theory-building model could be used in building a research project for HRD.

## Why Theory in HRD?

According to Reynolds (2007), scientific knowledge should provide a typology, the ability to predict future events, the ability to explain past events, a sense of what cause events and perhaps an ability to control events. New ideas, or theories, in science should possess certain attributes: abstractness or independence from time and space, intersubjectivity or general agreement among scientists about definitions and internal rigor, and empirical relevance or a repeatable connection between the theory and empirical research (Reynolds, 2007). "Good theory goes beyond establishing empirically observed patterns, that is, it tries to explain what caused them" (Van de Ven, 1989, p. 487).

In reality, we operate our lives on personal theories in practice (Lynham, 2002b). On a daily basis we experience new phenomena, observe it to understand more, test what we learn and, if useful, incorporate the new learning. If not useful, we may make additional observations or reject the new ideas. We may even informally share this new learning with others (Lynham, 2002b). "Theories, then, serve to satisfy a very human 'need' to order the experienced world. The only instrument employed in the ordering process is the human mind and the 'magic' of human perception and thought" (Dubin, 1978, p. 7).

Consider, for example, a person who regularly commutes to work by automobile for 30 minutes each day. Suppose that person always and only listens to a news-talk radio station for the duration of the drive. Without warning, one day that radio station changes formats to soft jazz music. The avid news-talk fan might first wonder if indeed the station has changed, check to see if the news talk radio format changed to a different station, and look for a different news talk station elsewhere. Still not finding the news talk station, that person returns to the soft jazz station to give it a try even while remaining concerned that not having information learned from the news talk experience each morning might create a daily knowledge vacuum. After several days of listening to the soft jazz format the commuter feels more relaxed and prepared to meet the day upon reaching work and concludes that listening to the soft jazz music caused this new feeling. One day at lunch, when asked by colleagues about favorite radio stations, the commuter shares the experience of the changing radio format and declares that the change to soft jazz made life better, concluding, "I can't explain it, I just know it."

In this example the commuter was presented with a phenomenon, the change in format of a radio station (experiencing the change). After conducting some basic fact-finding to determine if the station had indeed changed formats (observations to understand) the commuter decides to listen to the new format for a few days (testing new ideas). After a few days the commuter concludes that the new format is more relaxing (incorporating new learning), and shares anecdotally with others about the positive impact of soft jazz music on one's outlook on life (informal sharing). The commuter may now believe the personal and practical theory that listening to soft jazz music on the daily drive to work creates a positive and relaxing way to start and end the work-day.

The process used by the commuter to get to this conclusion or personal theory, experience, observe, test, evaluate, and share, resembles the process of theory building. Certainly these personal theories in practice help us order the way that we live (Lynham, 2002b). However, "I just know it" may not be sufficient evidence for others to change their radios to soft jazz music. To move personal theories in to the realm of academic theory building requires relevance and a more rigorous theory developing process, or what Van de Ven (1989) refers to as validity and utility.

Theory forms a key part of the foundation of research in adult education and human resource development (Van de Ven, 1989; Torraco & Holton, 2002; Merriam, 2008). To meet these attributes for new knowledge examining theory building as a research process requires a narrower definition of the word theory that does not include vague generalizations of events or things, descriptions of ideal societal conditions, and untested hypotheses

(Reynolds, 2007). The next section provides an overview of the theory building methodologies of Robert Dubin and Susan Lynham.

## Dubin's Model of Theory Building in Human Resource Development

Reynolds (2007) describes two general approaches to theory building, one that he calls theory-to-research, a more deductive approach, and a second called research-to-theory, a more inductive approach. The research-to-theory approach lends itself more to quantitative design where the researcher constructs a theory then confirms or disconfirms the theory. The theory-to-research approach lends itself more to qualitative design where the theory emerges over time as a result of the research. This section describes two models of theory building research, one by Robert Dubin and a second by Susan Lynham. Dubin's model is more specific and falls into the research-to-theory approach. Lynham's model is more inclusive and may employ either the theory-to-research or the research-to-theory approach. After providing an overview of each model, some comparisons will be made between the two followed by some comments about the context of Reynolds' general approaches to theory building.

Robert Dubin (1976, 1978) provides a model focused primarily on a theory-then-research approach labeled "quantitative hypothetico-deductive" by Lynham (2002a, p. 242). The eight steps of the model, units, laws of interaction, boundaries, system states, propositions, empirical indicators, hypothesis, and continuous application divide into two parts, the first to analyze the components of a theory and the second to examine how a theory connects to the empirical world of practice and research (Dubin, 1978). Dubin goes into considerable detail to describe the eight steps of his theory-building model, presented here in

brief form. The first four steps of the model concern the structure of the model, the last four the operationalization of the model.

Units are the components used to create a theory and may be attribute or variable, real or nominal, primitive or sophisticated, and organized as a member or a collective. Beyond that Dubin describes the types of units using the mnemonic EARS, for enumerative, associative, relational and statistical (Dubin, 1978). Finally, Dubin provides guidance for how to select units and strategies for inventing units (1978).

In step two, laws of interaction, Dubin refers to scientific laws of interaction, that is, laws that analyze the relationship between units. Laws of interaction may be one of three categories: categoric interactions, sequential interactions, or determinant interactions. The efficiency of a law of interaction may be shown by the range of variability in the values of a unit related by a law of interaction to the values of another unit. Dubin defined efficiency in four levels, in this order from lowest to highest: presence-absence, directionality, covariance, and rate of change (Dubin, 1978).

Dubin defines step three, boundaries, as the known limiting values of both the units and the laws of interactions. The limiting values may be defined by the internal criteria of the model or by external criteria. Boundaries help define the domain of the model, the area about which truth tables may be constructed that help define the units. Another way to say this would be that boundaries define the domain or the parameters within which the theory holds true. Dubin calls establishing the size of the domain (by determining the boundaries of the theory) one of the most important empirical tests of the model (Dubin, 1978).

Dubin defines the fourth and last structural component of his model of theory building, system states, by three features: "(a) All units have characteristic values, (b) the characteristic values of units are determinant; and (c) the constellation of all units persists through time" (Dubin, 1978, p. 144).

System states vary from the outcome of a unit because they include multiple characteristics across a collection of units when the system is in a particular state. Although not required, models may have more than one system state (Dubin).

In defining step five, propositions, Dubin distinguishes propositions as predictions about the values of the units in a system, not as truth statements about the properties of a unit. Propositions concern the model in action, not just describing the units of the model. Dubin defines three classes of propositions: propositions that predict the values of one unit in relationship to other units, propositions that predict the values of units or a system state, and propositions that predict the movement between system states (Dubin, 1978). Propositions differ from laws of interaction in that laws describe the relationship between units and the propositions predict values of units.

Dubin defines step six, empirical indicators, as an operation used by a researcher to measure the values of a unit. The process includes two acts, the measurement operation and its value found as a result; the output may be a number, an ordinal position, or a category. Empirical indicators must be operational (duplicable) and reliable (consistent). Dubin goes on to explain what this means for each type of unit, as well as defining absolute indicators, such as race or gender, and relative indicators such as religious affiliation (Dubin, 1978).

Dubin defines step seven, hypotheses, as "predictions about values of units of a theory in which empirical indicators are employed for the named units in each proposition" (Dubin, 1978, p. 206). Thus, empirical indicators get substituted for units in order to make the hypothesis one that can be confirmed or disconfirmed. The number of hypotheses increases with the number of empirical indicators substituted for units in a proposition and this could lead to superfluous research. While the solution of consolidating empirical indicators may be useful, Dubin warns that it might also limit the establishment of new empirical indicators (Dubin).

In the eighth and final step, research, Dubin describes the relationship between research and theory. He writes, "We start, then with the explicit conclusion that theory and research are separable as distinctive operations but inseparable as necessary complementary components of scientific endeavor" (Dubin, 1978, p. 217). Dubin calls research to build a theory descriptive research and research to test a theory hypothesis testing. Both processes should be ongoing and one should inform the other in a continuous application of the theory (Dubin).

Bacharach (1989) provides a framework that helps to describe the relationships in some of the steps of Dubin's model, shown in Figure 12. Dubin's units become Bacharach's constructs, Dubin's empirical indicators become Bacharach's variables, a set of boundaries constrains the possibilities of the units or constructs, and Dubin's system state becomes the entire graphic enclosed in the circle. Bacharach also uses Dubin's propositions and hypotheses. Finally, Dubin's continuous application becomes Bacharach's generalizability.

Beyond representations inferred in the horizontal arrows Bacharach's model does not illustrate Dubin's laws of interactions (Bacharach, 1989, Dubin, 1976, 1978).

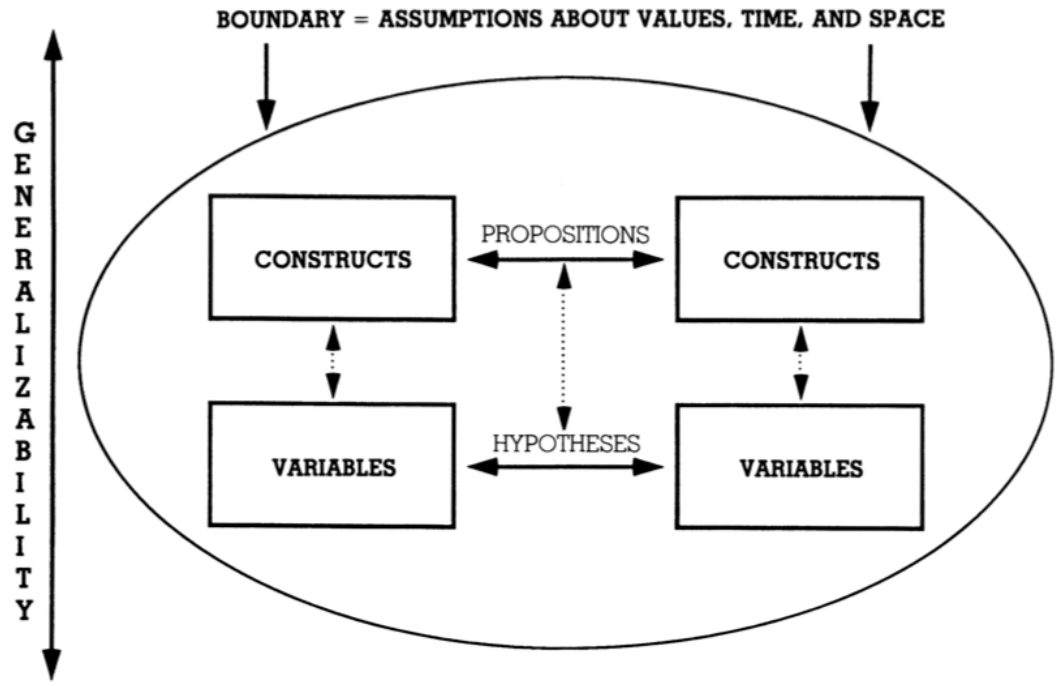


Figure 12. Bacharach's components of a theory. From "Organizational theories: Some criteria for evaluation," by S. B. Bacharach, 1989, The Academy of Management Review, 14(4), 496-515.

Bacharach's model provides a clear illustration between the first four steps of Dubin's model, the description of the components of a theory as units, laws of interaction, boundaries, system states, and the operationalization of a theory by determining propositions, converting units to empirical indicators, creating research hypotheses, and continuous application (Bacharach, 1989, Dubin, 1976, 1978). Figure 13 uses the graphical framework created by

Bacharach but uses Dubin's vocabulary and adds the two Dubin components not present in Bacharach's model. While this framework helps to describe how the components of Dubin's model interrelate, Dubin makes clear that the actual execution of the model should occur in the 8-step sequence.

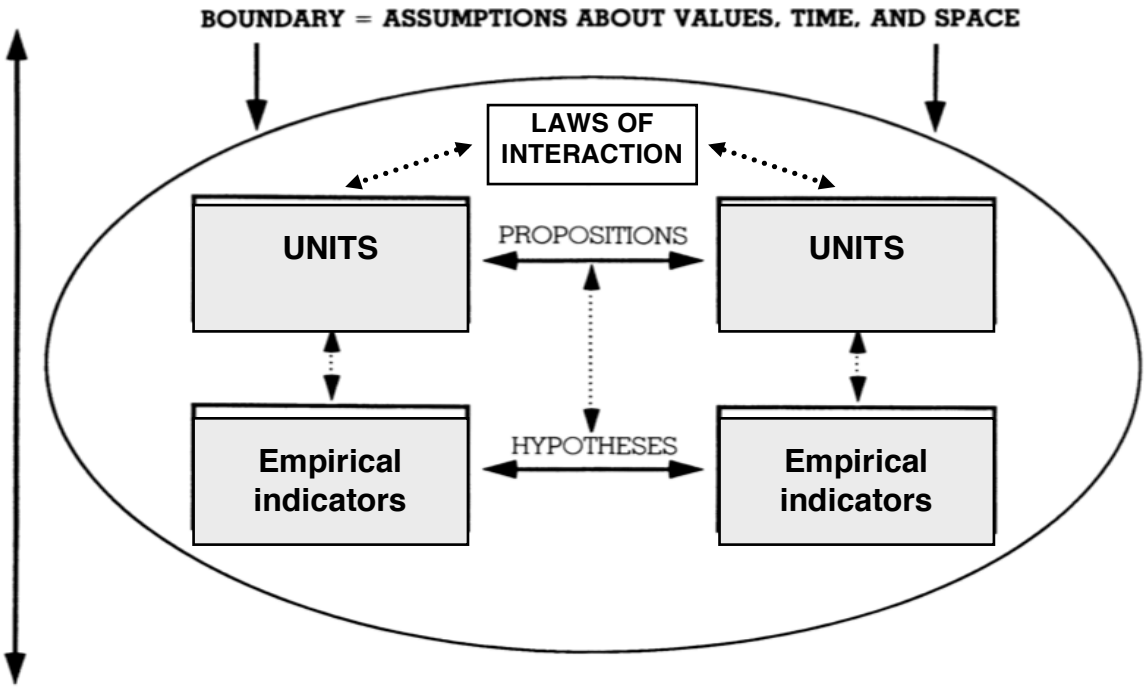


Figure 13. Dubin's theory building model using Bacharach's framework. Based on "Organizational theories: Some criteria for evaluation," by S. B. Bacharach, 1989, The Academy of Management Review, 14(4), 496-515 and Theory building, by R. Dubin, 1978, (revised ed.). New York: Free Press.

## Lynham's Model of Theory-building Research in Human Resource Development

Lynham (2002b) uses the three areas of scholarly inquiry delineated by Habermas (1984), empirical-analytical, interpretive, and critical as a framework from which to explore three broad approaches to theory building and research. Within these approaches, Lynham discusses two broad strategies for theory building identified by Reynolds (2007), theory-to-research (deductive) and research-to-theory (inductive). While these lenses certainly provide organizing structure to theory building, Lynham (2002b) contends that flexibility is key, and that the theorist must choose the approach and strategy best suited to the area of theory research. Additionally, all theory-building research processes share three elements in common: a system of knowledge and explanation, scholarly inquiry, and improved practical application. Lynham provides one-word labels for these: theory, research, and practice (Lynham, 2002b).

The steps in the Lynham's General Method of Theory-building Research in Applied Disciplines are: "conceptual development, operationalization, application, confirmation or discontinuation, continuous refinement and development" (Lynham, 2002a, p. 229). Figure 14 provides a visual representation of Lynham's model.

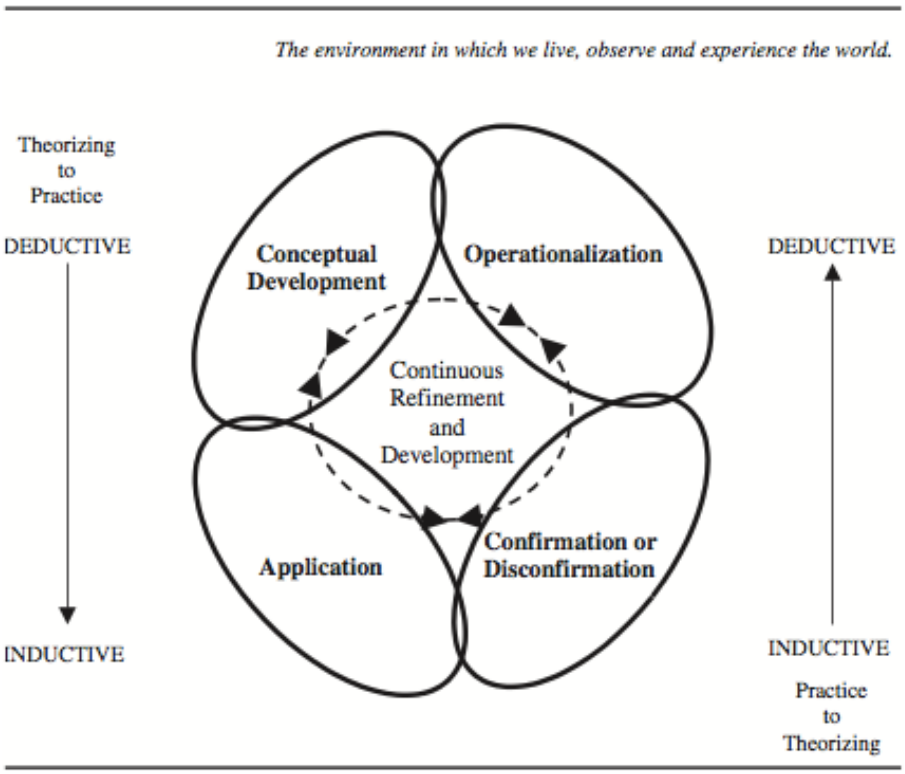


Figure 14. Lynham's general method of theory-building research in applied disciplines. From "The general method of theory-building research in applied disciplines," by S. A. Lynham, (2002), Advances in Developing Human Resources, 4(3), 221-241.

In the conceptual development phase the theorist describes the most developed explanation of the phenomenon to provide a framework for how the theory works. This includes the elements of the theory and how they interact with each other, any limitations, and the conditions by which the theoretical framework functions (Lynham, 2002b). The operationalization phase connects the conceptual framework to practice. The theorist converts the elements and how they interact into observable and thus, researchable, components such as propositions, hypotheses or empirical indicators. These two phases result

in an "operationalized theoretical framework," that is, a conceptual, relevant, explainable, theoretical framework with researchable components (Lynham, 2002b).

Operationalizing a theory leads to the confirmation and disconfirmation phase that consists of designing, implementing, and evaluating a research agenda that will either confirm or disconfirm the framework and its theory (Lynham, 2002b). The application phase provides the theorist the opportunity to see how the theory functions in practice. Is the theory useful and relevant? Does it improve practice and provide new insight? Experience with the theory in the practical world helps the theorist identify additional knowledge about the theory (Lynham, 2002b).

The fifth phase of the Lynham model, continuous refinement and development, may naturally occur in sequence after the application phase, but realistically this phase functions continuously, and in conjunction with each of the other phases. Ultimately, the recursive nature of the continuous refinement and development phase serves to sharpen both the rigor and relevance of the theory on an ongoing basis. This process would also identify any new propositions that render the theory false and therefore no longer of use (Lynham, 2002b).

Lynham goes on to discuss the limitations of the General Method of Theory-building Research in Applied Disciplines. While the process may begin with any of the five phases of the model and move forward in a flexible sequence, all phases of the model must be addressed to achieve "the outcome of a relevant, useful, and trustworthy research-based theory" (Lynham, 2002b, p. 234). Lynham's flexible theory-building model provides for two outcomes of a good theory: 1) outcome knowledge that may be predictive or explanative and 2) process knowledge that explains how something works. The model also provides for an

ongoing process through further research that continues to test and refine the theory (Lynham).

## Research Techniques That Support Theory-Building Methodology

This section provides an overview of research techniques that support theory-building methodology. In 2010, the editor of the HRDR, Thomas G. Reio, Jr., wrote an editorial about the need for more theory-building research methods articles. Citing excellent work by Lynham (2002a) and Torraco (2005), Reio suggests that the Instructor's Corner feature of the journal could be a place for sharing research strategies for research building (Reio, 2010). In subsequent issues Reio worked with Kim Nimon to describe how to use several quantitative research strategies to support theory building, including the use of cononical commonality analysis, measurement invariance, and regression commonality analysis (Nimon & Reio, 2011a, 2011b, 2011c). Nimon and Reio introduce these strategies for the general purpose of helping quantitative theorists gain additional insight to support their theories.

Dubin (1978) makes a distinction as to how research plays a role in theory building. "One of the common confusions to be found among researchers is that between doing research in order to build a theory and using research to test a theory. The first we call descriptive research. The second we call hypothesis testing" (Dubin, 1978, p. 218). Pointing out that many behavioral sciences researchers believe that descriptive research alone does not provide enough depth of analysis or predictive power to merit the expenditure of precious time and money, Dubin (1978) reminds us that it is description that allows us to define the units, laws of interaction, system states and boundaries of a model. He connects descriptive research to hypothesis testing research by pointing out that a theory is not scientific unless

some of its units may convert to empirical components that may be measured. Otherwise, a theory whose units are not empirically researchable is a belief system, not a scientific theory (Dubin, 1978). Dubin argues that completing the first four steps of his theory-building model requires the use of descriptive research and completing the last four steps of the model requires the use of empirical research. Lynham's general method of theory building allows for a variety of research techniques, including quantitative and qualitative techniques (Lynham, 2002b). Thus, this section addresses both qualitative and quantitative research techniques in support of theory-building research.

Torraco (2005b) provides an overview of five methods for theory building in applied disciplines. The five methods include Dubin's theory-building method, grounded theory building, meta-analytic theory building, social constructionist theory building, and case study research for theory building. Torraco goes on to explore grounded theory, meta-analysis, and case study in more detail. Grounded theory is unique in that it emerges from the data and therefore fits tightly with the data, and may yield truly previously unknown understandings. The strength of meta-analysis is its ability to synthesize other studies and uncover new meaning and directions (Toracco, 2005b). The meta-analysis researcher should assure that any new findings emanate from quality studies and through efficient analytic processes. Theory building from case study focuses on studying single settings and may include both qualitative and quantitative measures. Because it focuses on single setting case study research theory building can handle complex paradigms (Toracco, 2005b).

The case study for theory-building research process appears to be a promising methodology and starts with a well-developed research question, much like an empirical

study (Eisenhardt, 1989). As with empirical research design, crafting good questions in case study research helps the researcher stay away from irrelevant data. Specifying research constructs may prove useful in building theory through case study, especially if those constructs later emerge through the development of a theoretical framework. Having recognized the value of carefully- designed research questions and the identification of well-defined (and perhaps empirically researchable) theoretical constructs, the real strength of using case study research in the theory-building process lies in allowing the theory to emerge as the research progresses. To begin the process of using case studies in the theory-building research process investigators should form a research problem, describe some important variables, and reference important literature (Eisenhardt, 1989).

Eisenhardt goes on to suggest strategies for selecting which cases to include in building theory research. "Thus, the goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory" (Esienhardt, 1989, p. 537). The types of cases most likely to extend the emergent theory are not those selected randomly (as would be the case in an empirical study), however, but the cases that align with theoretical constructs, replicate previous cases, or sit at the polar edges of the theory (Eisenhardt, 1989). Using broad sampling strategies for selecting the case studies gives the researcher flexible avenues of approach into the data and informs the theory-building process. Van de Ven (1989) agrees adding, "Eisenhardt provides a useful, inductive strategy for building theories that are novel, testable, and especially appropriate for new topic areas" (p. 487). Dooley (2002) recommends a broad landscape of data-collection strategies that might be useful in case study research, including, "participant observation, document analysis, surveys, questionnaires,

interviews, Delphi processes, and others" (Dooley, 2002, p. 338), then asserts that this flexibility and the ability to analyze across cases is a sound reason to use case study research (Dooley, 2002).

Ravenswood (2011) provides a summary of Eisenhardt's (1989) building theories from case study research model and conducts a thorough citation analysis of Eisenhardt's work to determine its impact over a 20-year period. Highlights of the citation analysis show that Eisenhardt's article was cited over 2500 times up to 2008, by writers publishing in highly regarded and top tier journals (Ravenswood, 2011). Beyond this, a general Google Scholar search on October 29, 2012 showed 18,892 citations of Eisenhardt's (1989) article. Ravenswood goes on to point out that while the citations of Eisenhardt's work started out as support for selecting case study research as an appropriate theory building strategy, later citations were for the use of her framework. Ravenswood concludes that the use of case study research in the theory building process is more accepted, is growing, and that Eisenhardt's work was a valuable contribution to the area of theory building (Ravenswood, 2011).

Others use a variety of research techniques in support of theory building. Briggs (2007) used modeling techniques for theory building in a qualitative study, asserting that graphical representation of data can be useful for quantitative and qualitative analysis. Liao, Palvia, and Chen (2009) used confirmatory factor analysis to establish convergent validity in building a technology continuance theory. Chapman, (2007) combined Mezirow's transformative learning theory with Schwab's deliberative curriculum theory and a grounded theory approach to create a theory of curriculum development in the professions. Beyond that, Torraco and Holton (2002) created a "Theorist's Toolbox," that includes vocabulary and

definitions, criteria for evaluating theory, and a reading list. Perhaps a way to summarize this section would be to understand that one, the idea of building theory in the applied sciences is of value and that two, a variety of theory building techniques exist and have been utilized in the research.

## Professional Learning

### Introduction

This section of the review of literature explores professional development and its connection to how educators adopt technology to support teaching and learning. It begins with an overview of the National Staff Development Council, a definition of professional development, and a brief mention of terminology that serves to trace the progression of thinking about professional development over the years of the implementation of technology into classrooms (late 1980s to present). Examining professional development evaluation models yields insight about proven design elements. A section about professional learning communities highlights a more recent promising practice and provides a bridge to professional learning that includes the use of technology by educators and their application of using technology with students. The following section highlights the role played by the International Society for Technology in Education (ISTE) in establishing standards for education technology and the Partnership for 21st Century Skills for its work in identifying specific skills and professional development strategies focused on helping students succeed in the 21st century workplace. This section concludes by addressing key learning from

professional development models that apply to professional development in support of technology adoption.

Founded in 1969, the National Staff Development Council (NSDC) grew to reach 622 members in 1981 when the first issue of the Journal of Staff Development was published. By 1990, ten years later, membership grew to over 6,000, the annual budget exceeded one million dollars, and the annual conference was attended by well over 1,000 (NSDC, 2010). The NSDC published standards for staff development in 1995 that was revised in 2001. By 2010, with over 13,000 members, the organization transitioned its name from the National Staff Development Council to Learning Forward after whichthe standards went through another revision (Learning Forward, 2011, 2012; NSDC, 2010).

In 2009 the NSDC defined professional development as, "a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement" (NSDC, 2009, p. 2). This definition and its elaboration recognize but do not designate one of the innate complexities of professional development for educators, that the ultimate goal of helping educators learn is so that they may in turn help students learn. Thus, improving student achievement, a difficult measurement at best cases, becomes the key indicator of the effectiveness of professional development. The general process of this process is as follows:

> Based on a model of continuous improvement, the new definition engages educators in a cycle of analyzing data, determining student and adult learning goals, designing joint lessons that employ evidence-based strategies, providing coaching to support

improvement of classroom instruction, and assessing the effectiveness of educator learning and team-work on student learning." (NSDC, 2009, p. 1)

Hirsh (2009) provides further description of how the NSDC defined effective professional development and its processes. Professional development should focus on helping educators improve student achievement, align with state and local standards, and be conducted by in-house educational experts several times a week. This continuous cycle of improvement should evaluate data to determine student, teacher and school learning needs, set forth clear educator learning goals, implement learning strategies that improve student performance such as lesson study and developing formative assessments, and be supported by job-embedded coaching and other forms of assistance. Professional development should be assessed on an ongoing basis to determine if it effectively meets the learning goals for teachers and students. All of these continuous improvement processes may be supported by external expertise as appropriate such as networks, conferences, and workshops that are delivered by profit and nonprofit organizations.

Learning Forward published revised standards for professional learning in 2011, focused on improving educator effectiveness and student results. The seven standards are learning communities, leadership, resources, data, learning designs, implementation, and outcomes (Learning Forward, 2011). These standards provide an organizational schema for addressing the description of professional development published by NSDC in 2009. Educators, schools, and districts may use the standards to design, implement, improve, and evaluate professional learning experiences for educators.

## What do we call it?

Some call it staff development and others call it professional development. Still others call it professional learning. An interesting illustration of this occurs in Guskey's book, Evaluating Professional Development (2000). In writing the four-page forward, Dennis Sparks, a key contributor to the NSDC, used the term 'staff development' 30 times, and the term 'professional development' 7 times (Sparks used the term, 'professional,' mostly when referring to the title of the book or quoted material). In the first four pages of the introductory chapter of the book Guskey used the term 'professional development' 40 times and did not use the term staff development. Clearly the two were talking about the same thing but calling it by different names. Later, a name change for NSDC reflected a difference in approach. In 2010 the National Staff Development Council became Learning Forward (Learning Forward, 2012). The name change reflected an emphasis on educator learning as opposed to educator development.

Writing from an HRD perspective, Webster-Wright (2009) explored the nomenclature of professional development from a broad applied sciences perspective that included teaching, health, business, sciences, and social sciences. A variety of terms including, professional development (PD), continuing education, life-long learning, training, professional learning (PL), and staff development get used to describe the learning that occurs among practicing professionals (Easton, 2008; Webster-Wright, 2009). Among the more common terms, "training" educators implies a factory model of education and "developing" educators implies something done to educators by someone else (Easton). The term, continuous professional learning (CPL), asserts Webster-Wright, is not only

distinguishable from the other terms but it also best encapsulates the highest aspirations of the other terms. If, "effective PD is based on a notion of PL as continuing, active, social, and related to practice" (p. 703), then the term CPL proves an apt descriptor.

Thus, while deciding to use the term staff development or professional development may be more a personal preference, using the term professional learning over professional development denotes more than just semantics; it identifies a shift in practice. Professional learning denotes a process controlled by the learners, situated in classroom practice and based on data, focused on meeting the learning needs of participants, and honoring the professional expertise, experiences and skills of participants (Easton, 2008; Webster-Wright, 2008). Professional learning conducted in this way brings professional learning communities to life and promotes a professional culture of quality in the school (Easton).

On the opposite side of the self-directed learning continuum might be those who favor formal learning, where the expert is the knowledge giver and learners are the knowledge receivers. Despite movement towards more informal learning, formal learning may still be needed. Professional learning focused on situated procedural and transactional learning may mistakenly omit in-depth immersion into the nature of the content (McGuire & Gubbins, 2010). "If current trends continue, training and educational settings may become little more than informal learning incubators offering learners physical and technological experiential environments that promote active trial-and-error–based scenarios for creating and incorporating learning" (McGuire & Gubbins, p. 259). Global competition in a technology-driven educational environment will demand in-depth knowledge and this may require formal learning.

In addition to standards for professional learning, Learning Forward also identified four prerequisites for effective professional learning (2011). One, educators must be committed to meeting the learning needs of all students. Two, educators must be ready to learn as they engage in professional learning experiences and the learning must be relevant and useful. Three, educators should collaborate to create an honest and open environment of inquiry and learning that benefits individuals and the collective. Four, educators learn in different ways. Professional learning experiences should acknowledge these differences and help those involved manage their learning needs (Learning Forward, 2011).

Learning Forward called these prerequisites "implicit" in the standards, and "so fundamental that the standards do not identify or describe them. These prerequisites reside where professional learning intersects with professional ethics" (p. 3). With the exception of the first prerequisite, these speak directly to the conditions of andragogy outlined by Knowles (Knowles, et al., 2005). But what if these prerequisites are not so obvious to administrators, planners and participants? What if they are not in place? What if participants are not ready to learn, what if they are not accustomed to honoring individual experiences across the group, and what if all stakeholders are not accustomed to allowing for a broad array of learning styles and abilities?

Perhaps being more intentional about the Learning Forward prerequisites to professional learning (and other adult learning principles) would improve the process. Specifically, perhaps participants engaging in professional learning should explore the principles of andragogy and transformative learning.

"Creating professional development environments that cultivate freedom for critical questioning, reflective learning, and discussing and adopting new ideas can enable educators to create better understanding for themselves and consider extending their practice in new directions" (King, 2004, p. 169). Activities that promote transformational learning among educators include discussion, journals, reflection, and readings. Barriers to transformative learning include the need to be accepted by others and self-doubts about the risk taking required to critically reflect on practice. King asserts that both learners and facilitators bear responsibility for engaging in transformational learning:

> Bringing the learner into an active stance, and sharing the why and wherefore of the experiences not only allows them to take responsibility for their actions, but also for their learning. This strategy can potentially form a basis for increased self-directed lifelong learning beyond any formal professional development activity or graduate class and can change their own teaching practice. (King, 2004, p. 171)

## Insights from Professional Development Evaluation Models

This section provides a brief discussion about models and issues related to evaluating professional development. In the same sense that some would argue for curriculum planning that starts with backward design at the desired student outcomes (Wiggins & McTighe, 2005), and that professional development program planning should begin with the purpose and performance outcomes in mind (Cafferella, 2002), exploring evaluation models may reveal keys to determining how professional development could improve technology adoption in education.

In an extensive literature review of studies on professional development to integrate technology into teaching and learning, Lawless and Pellegrino (2007) point out key indicators of quality, including that professional development should focus on learning how to integrate technology with classroom activities and content, not just on how to use the technology. The authors point to the complexity of understanding how educator learning about the use of technology to support teaching and learning, a challenging process in and of itself, may ultimately impact student learning. Assigning attribution or determining causal relationships between technology-based professional development provided for educators and improvements in student achievement is complex. This may be a reason why so little empirical research on effective professional development on using technology in the teaching and learning process exists (Lawless & Pellegrino).

Lawless and Pellegrino suggest a three-phase model for evaluating the quality of professional development to support using technology for teaching and learning. Phase One studies the type and content, the duration and timing of professional learning opportunities, and the impact of technology support. Phase Two studies the impact on the knowledge, attitudes, and instructional behaviors of the professional development participants. Finally, Phase Three studies the impact of all of the above on student outcomes (2007). Each phase adds increasing sophistication to the needs of empirical research design.

Davies (2011) developed a 3-step model for technology literacy using the steps awareness, praxis (training), and phronesis (practical wisdom and competence). The Lawless and Pellegrino 2-phase model and the 3-step Davies model focus on getting beyond just

learning the technology to teacher wisdom around technology integration (Davies, 2011; Lawless & Pellegrino, 2007).

Program evaluation is the purposeful and systematic investigation of a program's value in order to determine its effectiveness and how to improve it (Kirkpatrick, 1998; Guskey & Sparks, 2002). As seen in Figure 15 Guskey defines five levels of evaluation for professional development (Guskey, 1991; Guskey & Sparks, 2002): participant reactions, participant learning, organization change and support, participant use of new knowledge and skills, and student learning outcomes. Each level requires increasingly more sophisticated evaluation methodology in terms of how to gather information and what to measure. Guskey also asserts that lower levels must be addressed in order to effectively address upper levels.

| Evaluation Level | What to evaluate | How to gather information | What to measure or assess | How to use information |
|---|---|---|---|---|
| 1. Participant reactions | Did participants enjoy the PD; leader's knowledge/helpfulness? | Questionnaires at session end | Did participants like environment, facilitator, and activities? | Improve program design and delivery |
| 2. Participant learning | Did participants acquire new knowledge and skills? | Instruments, simulations; participants demonstrations, reflections, and portfolios | New participants' knowledge and skills | Improve content, format and organization |
| 3. Organization support and change | Did organization provide support, advocacy, and resources? What was the impact on organizational culture and operation? | District/school records; questionnaires; structured interviews; portfolios | Organizational support, accommodation, and recognition | Document and improve organizational support; inform future change efforts |
| 4. Participant use of new knowledge and skills | Did participants apply new knowledge and skills? | Questionnaires; structured interviews; portfolios; audio-video evidence; observation; participant reflection | Degree and quality of implementation | Document and improve implementation of program content |
| 5. Student learning outcomes | Impact on student performance or achievement. Impact on other areas such as attendance, emotional factors. | Student/school records; questionnaires; structured interviews; portfolios | Student learning outcomes in cognitive, affective, and psychomotor area | Improve all aspects of implementation; demonstrate impact of professional development |

Figure 15. Levels of professional development evaluation. Based on "Does it make a difference? Evaluating professional development," by T. R. Guskey, 2002, Educational Leadership, 59(6), p. 48-49.

Kirkpatrick (1979), writing from more of an HRD perspective, describes program evaluation as a series of four steps: reaction, learning, behavior, and results. The first step, reaction, occurs typically in the form of a post-session survey and indicates how participants feel about the training program. The second step, learning, measures what participants learned to do during the training program. The third step, behavior, measures how

participants apply their learning to personal professional practice after the training program. The fourth step, results, measures how the training program changes the organization or, more specifically, how the actions of the participants in the training program contribute to affecting a desired change in the organization. The Kirkpatrick model closely aligns with the Guskey model; the fifth area in Guskey's model, how does the professional development impact student performance, highlights the key difference between the two (Guskey, 1991, 2002; Kirkpatrick, 1979, 1998, 2006).

Kirkpatrick provides guidelines for how to create a post-session survey that satisfies step one, reaction, including designing key items in a form that can be tabulated and quantified, adding free response space for comments, and making sure the form is anonymous. A typical form might include questions about satisfaction with the workshop, the facilities, and the facilitator on a Likert scale of 1-6, where six indicates most satisfied and one indicates least satisfied (Kirkpatrick, 1979, 1998).

With regards to step two, learning, Kirkpatrick rightly points out that measuring learning may be much more difficult than measuring reaction. Certainly others go in to great detail about how adults learn and how we know that they learn (Knowles, 1973; Mezirow, 1997; Brookfield, 2005; Merriam, Caffarella & Baumgartner, 2007). Kirkpatrick also points out that in the case of learning skills, performance by participants makes evaluating learning much more observable. Professional development for the use of technology to support teaching and learning fits this performance criterion with regards to the actual use and manipulation of the technology. That is, participants may demonstrate their knowledge of specific technologies by actually creating a project. This demonstration (and thus, evaluation

of an acquired skill) may be informal or more formal, as a personal reflection or for a facilitator, shared or individual (Kirkpatrick, 1979, 1998).

Step three of the Kirkpatrick evaluation model, behavior, measures how participants change their professional practice as a result of the training program. This step aligns with step four in the Guskey model, participant application of knowledge and skills. Another way to describe this process is the transfer of learning (Caffarella, 2002). Citing a 1956 article by Robert Katz, Kirkpatrick suggests that certain conditions must exist, including a desire by participants to learn and improve, an inviting and permissive environment that encourages participant learning, a learning facilitator interested in helping participants change behavior, and ample time for participants to apply new learning (Kirkpatrick, 1979). These conditions reflect many of the adult learning principles embodied in andragogy (Knowles, 1973). The transformative learning model describes this as a process of personal critical reflection and engagement with others to explore alternative viewpoints to one's frame of reference, in this case how teachers use technology to support teaching and learning (Mezirow, 1997).

Step four of the Kirkpatrick model, results, aligns with step three of the Guskey model, organization support and change, and focuses on how a professional development program may impact an organization. That is, how do the actions of participants in the training program help the organization effect a desired outcome. For example, a district outcome for professional development may be to increase the number of educators who use technology to support teaching and learning. A feedback form could provide evidence that participation in the professional development program resulted in changing personal behavior (actions) of the participants and in the actions and behavior of others. While some

(Cafferella, 1993, 2002; Holton III, 1996; Patton, 1998, 2002) may argue that the Kirkpatrick model does not address every aspect of professional development programs that should be evaluated, Kirkpatrick's 4-step model and Guskey's 5-step model provide a clear and usable framework for evaluating professional development for educator use of technology to support teaching and learning (Guskey, 1991, 2000, 2002; Kirkpatrick, 1979, 1998).

Examining evaluation models for professional development yields some insight as to how planners might design for professional development in the area of using technology to support teaching and learning. Professional development planners should focus on creating an inviting atmosphere for learning, helping participants learn things that can be put to use, contributing to change across the organization, and ultimately, impacting student performance. Effective professional development should do this by impacting educators' "knowledge, skills, practices, and eventually attitudes and beliefs" (Guskey & Sparks, 1991, p.75).

Hord and Hirsh (2008) provide an excellent description and overview of a promising practice for educator professional development, professional learning communities (PLC). Keying on the words in the name, PLCs engage professional educators in the collaborative and intentional process of learning focused on meeting the learning needs of students. "Members of the PLC are expected to acknowledge their own learning needs in their quest to support their students' success. Their true purpose must be improved staff and student performance …" (p. 26). Five key components of professional learning communities include: (a) shared values and vision by the community that lead to common goals, (b) shared and supportive leadership that improves staff self-efficacy, (c) collective decision making by the

staff as to what to learn and how to go about it, (d) support for the physical (materials, resources, logistics, spaces) and relational (intellectual, emotional) needs of all stakeholders, and (e) continuous peer-to-peer interaction and support (DuFour, Eaker, & DuFour, 2006; Hord & Hirsh). Success of the model depends on the degree to which all of a school's educators commit to improvement in student learning and to their roles and responsibilities in the PLC (Hord and Hirsh).

The professional learning community model focuses on professional educators as learners working together to improve student performance. The model depends on participants committing to their roles as learners and collaborators in the community. This type of learner-centered focus in professional development has also been useful in helping educators learn to use technology to support teaching and learning. The most important goal of professional development to help educators learn how to use technology in support of teaching and learning is similar to the ultimate goal of all educator professional development; that is, how can technology be used to promote improvements in student performance. The Apple Classrooms of Tomorrow (ACOT) researchers described profound changes in teacher practice over time as the teachers embraced the use of technology with their students (Sandholtz, Ringstaff, & Dwyer, 1997). This is commonly referred to as technology integration and is discussed in this chapter'searlier section on technology adoption models.

Examining online professional learning communities provides a nice illustration of the qualities of effective professional development and the additional challenges and opportunities presented by the use of technology. While leveraging the aspects of PLCs, including committed professional learners who collaborate in community to improve their

effectiveness, online PLCs also require participants to become comfortable using a variety of online technology tools. Typically this requires additional learning on the part of participants (Beach, 2012).

Online professional learning communities enjoy two advantages over traditional professional learning communities. First, they allow for asynchronous interaction among participants that alleviate pressures on time and immediacy. Second, because of increased comfort with technology and the ability to see the benefits for learning, educators who use online PLCs successfully may be more likely to use learning similar strategies with their students (Beach, 2012).

Online professional learning communities consist of four components: (a) a forum for teacher discussion about common goals and desired student outcomes; (b) teachers' personal learning networks, consisting of collections of digital objects, blogs, web sites, tweets and other resources; (c) accessible digital collections of student work that exemplifies agreed upon outcomes; and (d) a school-wide repository of shared lesson plans (Beach, 2012).

Creating an online PLC requires good leadership and planning, achieving buy-in from the faculty, perhaps running a pilot program to build out the community and hone its design, and ongoing face-to-face discussion to continuously improve the process (Beach, 2012). These findings mirror what others identify as critical components of successful professional learning communities: a supportive environment, opportunities to share personal practice, and collaborative learning and implementation (DuFour, Eaker, & DuFour, 2006; Early, 2012).

Professional development for technology integration typically introduces an additional dimension of learning for participants, the technology itself. Many agree that successful technology integration requires professional development, additional time to learn the technology and implement its integration, and technical and personal support from administration and other teachers (Buckenmeyer, 2010; Carter, 2009; Polly & Hannafin, 2010; Vannatta & Fordham, 2004). Learner-centered professional development is collaborative, ongoing, and reflective, and helps educators learn new content and pedagogies to support student learning. It is especially useful when learning new technology is also involved (Polly & Hannafin).

## Barriers to Technology Adoption

Failure to establish a learner-centered environment for professional development may influence the success of the technology implementations. Teacher beliefs and attitudes influence how they integrate technology and whether they focus on more student-centered use of technology or more teacher-directed use (Buckenmeyer, 2010; Polly & Hannafin, 2010; Vannatta & Fordham, 2004). Generally teachers tend to match their style of technology use to their instructional style: however, those who are introduced to the use of technology in a learner-centered, constructivist style may be more likely to employ constructivist methods when using technology with their students (Matzen & Edmunds, 2007).

Establishing the type of environment described by Hord and Hirsh (2008) requires a certain rigor on the part of teachers and administrators. If not, convenience may trump quality when teachers think about learning technology skills. Griffin (2003) found that the

top reasons given for choosing the type of technology learning by teachers were time and location; the reason given least often was that it was the best way to learn. Educators at different technology levels of integration (LOTI) tend to choose different methods of professional learning. "Learning by trial and error, peer support, and technology personnel support were the most frequently utilized training methods for learning technology integration skills by all groups" (Griffin, 2003, p. 99).

Generally, barriers to technology adoption in schools include a lack of vision, leadership, and money, the relative paucity of technology-enhanced curriculum, the need for a more sophisticated technology infrastructure, and parental resistance to 21st century methods and tools. Beyond that, schools must improve the human infrastructure by encouraging ongoing professional learning and understand that it takes time to create real change. Finally, schools and districts must implement meaningful assessment to continue to establish the important role played by technology in student achievement (Norris & Soloway, 2011).

Knowing and agreeing to good practices in professional learning does not always lead to implementation. "Even when administrators embrace the shifting view of professional development, their actions may serve to undermine, rather than support, key design principles" (Sandholtz & Scribner, 2006, p. 1105). Administrators may unknowingly impact the implementation through three connected beliefs that impact their actions: (a) a desire to exert administrator control or leadership, (b) they do not fully understand the rich nature teacher expertise, and (c) they intend to focus on standardized outcomes (Sandholtz & Scribner, 2006).

Another way to think about barriers for educators to implementing technology may be embedded in how they think about teaching and learning. Knowles (1973) examined the emergence of the tradition of pedagogy and how it skews educator general beliefs about teaching and learning. Pedagogy, the art and science of teaching children, emerged from the codification of educational values and practices during the middle-ages. Prior to this time the most renowned teachers, such as Plato, Aristotle, Socrates, Lao Tse, Confucious, and Cicero, primarily taught adults with methods such as inquiry, learning as a process of discovery, dialogue and learning by doing (Knowles, 1973).

In an effort to control the message and the learning, middle-ages monks squelched these methods, replacing them with prescribed instruction and rote memorization focused on reading and writing. Over the years this "tradition of pedagogy" (Knowles, p. 42) spread to secular schools and became entrenched in the educational systems of Europe and America. Too often, this tradition of pedagogy carries over to the teaching of adults. Knowles refers to this overreliance on using the traditions and methods used in teaching children to teach adults as "the millstone of pedagogy" (Knowles, p. 42).

Educators may get locked in to the millstone of pedagogy from an early age. Lortie (2002) describes what he called the apprenticeship of observation, a period of at least 16 years during which teachers experience a shallow observation of what teachers do. Being a student is an apprenticeship, of sorts, for teachers. Whether or not students determine to go into teaching they still spend more time with teachers than any other professional group. This time spent together, at least 16 years for those who become teachers, is close, interactive, and

depends on the student understanding how to interact with the teacher in order to be successful.

Lortie identifies two limits of this long-term, close apprenticeship. First, the student observes the teacher as if an audience member at a play, not someone watching from the wings who also observes backstage goings-on and the make-up of the set. Second, the student's participation in the teaching experience is imaginary, not real. In that sense, watching volleyball matches for years does not mean that the observer masters the technical skills of the game. The student's experience in observing the teacher does not extend to understanding the pedagogical underpinnings of why the teacher chooses a given strategy or action. "What students learn about teaching, then, is intuitive and imitative rather than explicit and analytical; it is based on individual personalities rather than pedagogical principals." (p. 62)

Generalized across individuals this imaginative view of teaching becomes tradition, a way of knowing about teaching that only knows part of the whole. Lortie also found that teachers tend to teach as they were taught, replicating, in a sense, the tradition, the less than whole version. "In that respect, the apprenticeship of observation is an ally of continuity rather than of change" (p. 67). The apprenticeship of observation only strengthens the tradition of pedagogy and makes the millstone of pedagogy all the heavier.

## Technology Professional Development for K-12 Educators

The recent report, Professional Learning in the Learning Profession: A Status Report on Teacher Development in the U.S. and Abroad, issued by the National Staff Development Council (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009) provides a good

starting point for examining K-12 educator professional learning in the use of technology because it makes recommendations for the general design staff development. More specifically, the areas of teachers learning how to use technology in the teaching and learning process, and learning how to help students learn 21st century skills attract a great deal of attention. These areas may be addressed by examining key documents from ISTE and P2

The National Staff Development Council (NSDC) formed in 1969 as an effort to bring together those responsible for staff development in school districts. The organization grew over the years to a membership of 13,419 and a budget of 8 million dollars. The organization publishes research findings and best practices in the area of staff development for K-12 education and educational policy around staff development (NSDC, 2010). For example, NSDC joined with 17 other professional organizations to create the Standards for Staff Development that have been adopted or adapted by 40 states (Wei, et al., 2009).

In 2009 NSDC published a revised Definition of Professional Development that was included in the proposed reauthorization of No Child Left Behind Act of 2001 (NSDC, 2009). NSDC also commissioned the School Redesign Network at Stanford University to help with a multi-year study, The Status of Professional Development in the United States. NSDC published part one of the study, Professional Learning in the Learning Profession: A Status Report on Teacher Development in the United States and Abroad in 2009 (Wei, et al., 2009). Figure 16 lays out design principles for professional development.

| | **Professional Development should:** |
|---|---|
| **Principles** | - Be intensive, ongoing, and connected to practice.<br>- Focus on student learning and address the teaching of specific curriculum content.<br>- Align with school improvement priorities and goals.<br>- Build strong working relationships among teachers. |
| **Other Strategies** | - School-based coaching may enhance professional learning.<br>- Mentoring and Induction programs for new teachers may support teacher effectiveness. |

Figure 16. NSDC principles for designing professional learning. Adapted from "Professional Learning in the Learning Profession: A Status Report on Teacher Development in the United States and Abroad," by R. C. Wei, L. Darling-Hammond, A. Andree, N. Richardson, & S. Orphanos, 2009, National Staff Development Council, pp. 9-13.

The International Society for Technology in Education (ISTE), a non-profit membership organization, seeks to improve PK-12 and teacher education by promoting the effective use of technology by educators and learners. ISTE develops and manages the National Educational Technology Standards (NETS), and the National Educational Computing Conference (NECC), representing over 85,000 professionals worldwide. ISTE divides the NETS into several categories, including technology standards for students, teachers, and administrators in PK-12 environments and teacher preparation programs. "More than 90% of all states in the United States use NETS or a NETS derivative for educational technology planning" (ISTE, 2006, p. 4). Figure 17 excerpts Standard Five from the NETS-T for teachers and Standard Three from the NETS-A for administrators to highlight ISTE thinking about professional development in the area of using technology to support teaching and learning in K-12 environments.

| Context - Standard | Standard Indicators |
|---|---|
| Teachers Standard 5. Engage in Professional Growth and Leadership<br><br>Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources. | Teachers:<br>- Participate in local and global learning communities to explore creative applications of technology to improve student learning<br>- Exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others<br>- Evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning<br>- Contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community |
| Administrators Standard 3. Excellence in Professional Practice.<br><br>Educational Administrators promote an environment of professional learning and innovation that empowers educators to enhance student learning through the infusion of contemporary technologies and digital resources. | Administrators:<br>- Allocate time, resources, and access to ensure ongoing professional growth in technology fluency and integration<br>- Facilitate and participate in learning communities that stimulate, nurture, and support administrators, faculty, and staff in the study and use of technology<br>- Promote and model effective communication and collaboration among stakeholders using digital-age tools<br>- Stay abreast of educational research and emerging trends regarding effective use of technology and encourage evaluation of new technologies for their potential to improve student learning |

Figure 17. National Education Technology Standards for Teachers (NETS-T) and Administrators (NETS-A), with the focus on professional development. Adapted from "National Education Technology Standards for Teachers," 2008, and "National Education Technology Standards for Administrators," 2009, by the International Society for Technology in Education (ISTE), Portland, OR.

In 2002 The U.S. Department of Education and a group of business and education organizations founded the Partnership for 21st Century Skills (P21). According to P21 a "profound gap" exists between the skills most learned in schools today and the skills

American children will need to succeed in 21st century communities and workplaces. Hence, P21 describes its mission as building partnerships across business, education, community, and government institutions that focus 21st century skills at the heart of United States K-12 education efforts (P21, 2004). Usually referred to as 21st century skills, P21 provides detail for what they mean by this as "21st century student outcomes, … a blending of content knowledge, specific skills, expertise and literacies" (P21, 2009, p. 8), as shown in Figure 18.

| | |
|---|---|
| Mastery of Core Subjects, along with 21st Century Themes | - Global Awareness<br>- Financial, Economic, Business, and Entrepreneurial Literacy<br>- Civic Literacy<br>- Health Literacy<br>- Environmental Literacy |
| Learning and Innovation Skills | - Creativity and Innovation<br>- Critical Thinking and Problem Solving<br>- Communication and Collaboration |
| Information, Media, and Technology Skills | - Information Literacy<br>- Media Literacy<br>- ICT (Information, Communications, and Technology) Literacy |
| Life and Career Skills | - Flexibility and Adaptability<br>- Initiative and Self-Direction<br>- Social and Cross-Cultural Skills<br>- Productivity and Accountability<br>- Leadership and Responsibility |

Figure 18. 21st century skills student outcomes. Adapted from "Framework for 21st Century Learning," by Partnership for 21st Century Skills (P21), 2007, Tucson, AZ, pp. 1-2.

P21 (2006) also described 21st century skills professional development that should prepare teachers and principals to integrate 21st century skills into their classrooms and schools. Including a comprehensive emphasis on these skills, and an alignment with

standards, curriculum and assessments, successful 21st century professional development programs share several common characteristics as listed in Figure 19.

| Context | Common Characteristics |
|---|---|
| Prepare educators to integrate 21st century skills into classrooms and schools. | - Ensure educators understand the importance of 21st century skills and how to integrate them into daily instruction.<br>- Enable collaboration among all participants. |
| Part of comprehensive emphasis on skills | - Allow teachers and principals to construct their own learning communities.<br>- Tap the expertise within a school or school district through coaching, mentoring and team teaching. |
| Align with standards, curriculum, assessment | - Support educators in their role of facilitators of learning.<br>- Use 21st century tools. |

Figure 19. Characteristics of 21st century skills professional development programs. Adapted from "Professional Development for the 21st Century," by Partnership for 21st Century Skills (P21), 2006, Tucson, AZ.

## Analysis

NSDC, ISTE and P21 each provide a unique lens through which to view the challenge of designing professional development for educators in the areas of technology and 21st century skills. Rightly so, the documents published by these organizations focus on how educators may help students succeed. Figures 16, 17, and 19 pull top-level design principles for professional development from each organization. When combined together the tables form an interesting matrix for thinking about professional development in the context of technology and 21st century skills. Figure 20 lays out that matrix by four areas of commonality: learning communities, content, coaching, and teaching. Interestingly, this

matrix includes a strong focus on collegial communities and coaching, areas that may not naturally occur to educators when they think of professional development for technology and 21st century skills. In that sense, the values included in the matrix model some of the 21st century skills listed in Figure 18. The focus on engaging educators in collegial (perhaps global) learning communities indirectly implies that they will be self-directed and internally motivated to learn with and from each other, with a clear understanding of how these learning communities will address problems in teaching and learning. These are conditions of adult learning listed in Figure 11.

| | NSDC | NETS | P21 |
|---|---|---|---|
| **Learning communities** | Professional development should build strong working relationships among teachers. | Teachers participate in local and global learning communities to explore creative applications of technology to improve student learning. | Allow teachers and principals to construct their own learning communities.<br><br>Enable collaboration among all participants. |
| **Content** | Professional development should focus on student learning and address the teaching of specific curriculum content. | Teachers evaluate and reflect on current research and professional practice on a regular basis to make effective use of existing and emerging digital tools and resources in support of student learning. | Ensure educators understand the importance of 21st century skills and how to integrate them into daily instruction.<br><br>Use 21st century tools. |
| **Coaching** | School-based coaching may enhance professional learning.<br><br>Mentoring and Induction programs for new teachers may support teacher effectiveness. | Teachers exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others. | Tap the expertise within a school or school district through coaching, mentoring and team teaching. |
| **Teaching** | Professional development should be intensive, ongoing, and connected to practice.<br><br>Professional development should align with school improvement priorities and goals. | Teachers contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community. | Support educators in their role of facilitators of learning.<br><br>(Ensure educators understand the importance of 21st century skills and how to integrate them into daily instruction.) |

Figure 20. Matrix for Professional Development in Technology and 21st Century Skills. Adapted from "Professional Development for the 21st Century," by Partnership for 21st Century Skills (P21), 2006, Tucson, AZ, and "Framework for 21st Century Learning," by Partnership for 21st Century Skills (P21), 2007, Tucson, AZ, pp. 1-2, and "National Education Technology Standards for Teachers," 2008, and "National Education Technology Standards for Administrators," 2009, by the International Society for Technology in Education (ISTE), Portland, OR.

Combining Figure 11, The Conditions and Processes of Adult Learning, with Figure 20 provides a way to examine the adult learning elements in the documents from NSDC, NETS, and P21. The first column in Figure 21 combines the content from Figure 11 into one column, the conditions and processes of adult learning, using the step-by-step sequence previously discussed. The content from Figure 20 has been slightly reworked and placed in columns 2-4 of Figure 21. While the content in the adult learning column makes an easy sequence columns 2-4 should not be read as a sequence but rather to see if that organization specifically addresses the conditions and processes of adult learning. Blanks or partial content indicate less focus on that condition or process. For example, the content from NSDC and P21 does not specifically address the learning environment. Certainly, one should not conclude that these organizations do not support conducting professional development in an adult-appropriate environment, rather that the top-level principles listed in the documents cited do not specifically address this.

| Adult Learning Conditions and Processes | **Professional development should support educators to:** | | |
|---|---|---|---|
| | NSDC | ISTE-NETS | P21 |
| Environment | | (Administrators) create supportive environment, model use of tools, and participate in learning. | |
| Status | | Share decision making and community building | Construct learning communities. |
| Readiness | Engage in learning that is intensive, ongoing, and connected to practice. | Exhibit leadership by demonstrating a vision of technology infusion. | Understand the importance of 21st century skills. |
| Planning<br><br>Process: Critical Reflection | Align their learning with school improvement goals to focus on student learning and address the teaching of specific curriculum content. | Evaluate and reflect on current research and professional practice on a regular basis to make effective use of digital tools and resources in support of student learning | Learn how to integrate 21st century skills into daily instruction. |
| Performance<br><br>Process: Work with Frames of Reference<br><br>Process: Dialogue to Re-frame | Build strong working relationships among teachers.<br><br>Include school-based coaching, mentoring, and new teacher induction programs to enhance professional learning. | Contribute to the effectiveness, vitality, and self-renewal of the teaching profession and of their school and community<br><br>Participate in local and global learning communities to explore creative applications of technology to improve student learning<br><br>Develop the leadership and technology skills of others | Become facilitators and collaborators in learning.<br><br>Use 21st century tools.<br><br>Tap the expertise within a school or school district through coaching, mentoring and team teaching |
| Reflection | (implied - ongoing) | (implied - ongoing) | (implied - ongoing) |

Figure 21. Adult Learning Elements in NSDC, ISTE-NETS, and P21 Professional Development. Adapted from "Professional Development for the 21st Century," by Partnership for 21st Century Skills (P21), 2006, Tucson, AZ, and "Framework for 21st Century Learning," by Partnership for 21st Century Skills (P21), 2007, Tucson, AZ, pp. 1-2, and "National Education Technology Standards for Teachers," 2008, and "National Education Technology Standards for Administrators," 2009, by the International Society for Technology in Education (ISTE), Portland, OR, and "Transformative Learning: Theory to Practice," by Jack Mezirow, 1997, New Directions for Adult & Continuing Education, 74(5), and The adult learner. The definitive classic in adult education and human resource development, by M. S. Knowles, E. F. Holton, III and R. A. Swanson, 2005, (6th ed.), Burlington, MA: Elsevier.

At first glance, the NSDC-ISTE-P21 models seem to address quite a few areas of adult learning. A closer look at Figure 21 reveals that the NSDC-ISTE-P21 models may be more ambiguous in addressing some of the areas. Indeed, Figure 21 makes for a rough fit in some cases. For example, Status and Readiness involve a deep understanding of why the learning is important, an ability to apply personal experience to solve authentic professional problems and an increasing level of self-directedness, motivated by an internal desire to learn. While the models suggest that learners should understand the vision and voluntarily enter into a professional learning community (PLC) they do not address a deep understanding of questions such as, "What kind of learner am I?" and "Why will I learn this?" or "Am I ready to learn?" Hord and Hirsh (2008) explain in greater detail who should participate in a PLC, what work should dominate a PLC, and how a PLC should support educator learning. On another note, combining the conditions for adult learning with Mezirow's (1997) process of understanding frames of reference and how to re-frame creates a complex and interdependent model. This complexity and interdependence may not be present in the NSDC-ISTE-P21 documents.

## Putting It All Together

This section presents a broad survey of two areas of adult learning and three areas of K-12 educator professional development. It relies on the work of Knowles and Mezirow for adult learning principles, and NSDC, ISTE, and P21 documents to structure professional development in the areas of technology and 21st century skills. The purpose of the section is to examine the NSDC-ISTE-P21 documents for elements of adult learning and to make suggestions for the design of professional development. Regarding the first purpose, the

NSDC-ISTE-P21 documents absolutely do address conditions and processes of adult learning; however, they do not provide a deep focus. As evidenced by the lack of depth in the areas connected to professional development, these documents may still be focused on the ever-present-in-education issue of how this will help students succeed.

This set of recommendations may form a starting point for refocusing professional development to account for the conditions and processes of adult learning.

- Actively orchestrate an adult learning environment.
- Develop activities that help educators understand what adult status means as a learner.
- Spend quality time at the beginning of professional development to be sure that educators prepare themselves to engage in learning.
- Collaborate with participants to plan objectives.
- Develop activities that cause participants to engage in the process of critical reflection, understanding frames of reference, and dialoging to reframe.

This list also forms recommendations for future research and exploration. Each of these points merits a separate in-depth examination against the NSDC-ISTE-P21 documents. Another way to advance this topic would be an in-depth investigation of each of the conditions of adult learning across technology professional development and the 21st century skills movement (and not just focused on these documents). In the spirit of Knowles and Mezirow it may be time to cast off the millstone of pedagogy on the design of professional development, critically evaluate our current models, and rethink our frame of reference.

| Section of Literature Review | Key Postulates |
|---|---|
| Technology Adoption Models | Several key models have guided exploration around how educators adopt technology into the teaching and learning process. The Technology Adoption Model (Venkatesh & Davis, 2000) focuses on the general use of technology. The Apple Classrooms of Tomorrow (Sandholtz et al., 1997; Dwyer et al., 1990) focuses on the use of technology specifically to support educators and learners. The Concerns Based Adoption Model (Hall, 1976) focuses on how educators adopt innovation. The Diffusion of Innovations Theory (Rogers, 2003) focuses on how innovations get adopted. Each unique model brings a slightly different perspective but all of the models include steps or stages of a change process. |
| Educator Professional Development | Organizations such as the NSDC-Learning Forward (2001, 2009, 2010, 2011, 2012), ISTE (2007, 2008), and P21 (2004, 2006, 2007, 2009) provide models for how educators should use technology to support teaching and learning and make recommendations for the design of professional development. While some (NSDC, 2001, 2010; ISTE, 2008) include some elements of adult learning principles they do not specifically identify adult learning theory as foundational. Instead, they focus on how the professional learning supports student learning.<br>Guskey (1991, 2000, 2002) and Kirkpatrick (1979, 1998) offer good models for evaluating educator professional development that also serve as design criteria, including results, learning, change in behavior, and organizational change. |
| Adult Learning Theory | Two adult learning theories offer insight that could be useful for creating a theory of educator professional learning on technology adoption. Andragogy, developed by Malcolm Knowles (Knowles,1973; Knowles et al., 1998)) defines the conditions and processes of adult learning. Transformative learning, developed by Jack Mezirow (1994, 1997) explains the critical reflection necessary for adults to resolve a disorienting dilemma that challenges their existing frames of reference. |
| Theory and Theory-building Research | The field of HRD recognizes the need for more theory building to advance the field. Dubin's (1978) method of theory-building research is well-documented and centers around an eight-step process. Holton and Lowe (2007), Lynham (2000, 2002a, 2002b), and Garcia (2008) provide critique, examples, and description of Dubin's model. Patterson (1986) provides a well-tested model for evaluating theory. |

Figure 22. Summary of Key Postulates Resulting from the Literature Review.

# CHAPTER THREE

# METHODOLOGY

This chapter provides a description of the methodology used in this study. The chapter begins with a brief review of the research direction and purpose of this study. Next, an overview of theory-building research approaches leads to an explanation for why Dubin's method was chosen for this study. The final section of the chapter describes the steps used in the theory-building research process.

## Research Direction

Those who research and write about educator adoption of technology to support teaching and learning use models to explain how the adoption occurs. The models divide into three categories. The first model examines the perceived usefulness and ease of use of the technology, best exemplified by the Technology Adoption Model (TAM). A second model describes the adoption of technology by educators as a series of steps or stages of ever-increasingly sophisticated integration of technology into the teaching and learning process by both teachers and students, best exemplified by the Apple Classrooms of Tomorrow (ACOT) model. A third model focuses on how educators pass through a change model as they adopt technology for teaching and learning, best exemplified by the Concerns Based Adoption Model (CBAM). While all three models include elements of educators as learners none specifically identifies adult learning principles as instrumental to core processes.

As demonstrated in Chapter Two's literature review, two areas of adult learning theory add important ideas to the processes involved with educator adoption of technology to support teaching and learning. Andragogy provides a set of conditions and elements of adult

learning, a platform upon which to orchestrate adult learning experiences, including environment, status, readiness, planning, performance and reflection (Knowles, 1973; Knowles et al.,1998; Rachal, 2002). Transformative learning addresses how unique contextual areas such as race, gender, and age might influence educators as they search out how to identify and work through their personal disorienting dilemmas around the adoption of technologies (Mezirow, 2000, 1997). Although not specifically called out as adult learning or associated with Mizerow or Knowles, elements of andragogy and transformative learning may be found in various technology adoption models.

The TAM went through several revisions over the years (Davis & Venkatesh, 1996; Venkatesh & Bala, 2008; Venkatesh, Morris, Gordon & Davis, 2003; Venkatesh & Davis, 2000). Many of the additions to the model address elements of adult learning principles without calling them out as adult learning. For example, the TAM2 (Venkatesh & Davis, 2000) adds the determinants of experience, voluntariness, and job relevance to explain the perceived usefulness of technology, all also part of andragogy (Knowles et al, 1998).

The ACOT model describes a series of stages or steps through which educators pass as they embrace the use of technology to support teaching and learning. The first three stages, Entry, Adoption, and Adaptation, focus on incremental usage of technology that involves learning increasingly more about how to use technology and applying new tools to known curriculum. The fourth and fifth stages, Appropriation and Invention, involve rethinking the entire approach to curriculum and using new tools to explore new ways of teaching and learning (Dwyer et al., 1990; Sandholtz & Ringstaff, 1996). The processes required to achieve this relate very well to transformative learning, described by Mezirow,

where adults engage in critical reflection to rethink their frames of reference (Mezirow, 2000, 1997).

The CBAM describes what participants (or, educators in this case) feel and experience as they explore the usefulness and ease of ease of technologies, and as they move through the stages of adoption. The breadth of CBAM allows it to address the change process across the conditions of adult learning embedded in andragogy as well as areas of transformative learning (Hall, 1976; Loucks, Rutherford & Newlove, 1975; Straub, 2009).

A gap exists, therefore, between adult learning theory and educator technology adoption models. Pulling elements of the adult learning theories together with the technology adoption models allows for the creation of an adult learning-based theory of educator technology adoption. The outcome of this combination should provide for an enriched, more nuanced look at how educators may address the use of technology to support teaching and learning. An adult learning-based theory of educator technology adoption could provide insight into educator professional learning thus helping professional developers, administrators, and educators improve the learning technology adoption experience.

The purpose of this study is to use adult learning theory to conceptualize a broader theory of educator professional learning and technology adoption and to develop a framework that operationalizes the theory. The research questions include the following:

1. Can adult learning theory be used to develop a theory of educator professional learning for technology adoption?
2. Can adult learning theory be used to conceptualize a theory of educator professional learning for technology adoption?

3. Can an adult learning based theory of educator professional learning for technology adoption be operationalized?

The next section describes a theory building research paradigm, approach, and strategies derived from the literature, and explains the appropriateness of this process for this study.

The first step in structuring a theory-building research process entails determining the research paradigm. Gioia and Petre (1990) define theory "as any coherent description or explanation of observed or experienced phenomena. Theory building," they write, "refers to the process or cycle by which such representations are generated, tested, and refined" (p. 587). The authors use a 2 x 2 matrix of four research paradigms constructed by Burrell and Morgan (1979) to broaden their approach to theory building. The four paradigms in Figure 23, interpretive, functionalist, radical humanist, and radical structuralist, represent different perspectives on beliefs about phenomena, and the nature (ontology), knowledge about (epistemology), and ways of studying (methodology) phenomena (Holton & Lowe, 2007; Gioia & Petre, 1990). Because the paradigms are discrete and unique, they provide a foundation from which to proceed with theory building (Holton & Lowe).

Within the interpretivist paradigm, the theory builder seeks to understand how the ways that individuals construct their own organizational realities ultimately reveal patterns (Gioia & Petre). Within the radical humanist paradigm, the theory builder adds critical evaluation to the interpretivist perspective, seeking to free individuals from hegemony and exploitation through radical change (Gioia & Petre). Within the radical structuralist paradigm, the theory builder looks more at the organizational level, seeking transformation of

systems achieved through radical change and resistance (Gioia & Petre). Within the functionalist paradigm, the theory builder "seeks to examine regularities and relationships that lead to generalizations and (ideally) universal principles" (Gioia & Petre, p. 590).

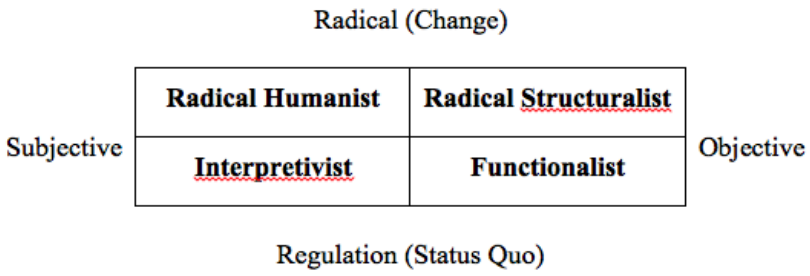


Figure 23. Burell and Morgan's (1979) four paradigms. Based on Sociological paradigms and organizational analysis, by G. Burrell and G. Morgan, 1979, London: Heinemann, and "Multiparadigm perspectives on theory building," by D. A. Gioia and E. Pitre, 1990, The Academy of Management Review, 15(4), pp. 584-602.

While Gioia and Petre (1990) find some commonality across the paradigms they conclude that mixing the approaches proves difficult in terms of methods, vocabulary, goals and assumptions. This does not, however, prevent the use of these paradigms to broaden one's vision across multiple approaches. Choosing a paradigm from which to build theory is necessary; understanding that multiple paradigms exist and allowing for the differences may be informative across the theory building process.

The purpose of this study is to apply adult learning principles to technology adoption models to create an adult learning-based theory of educator technology adoption. Beyond the core models of andragogy (Knowles, 1973) and transformational learning (Mezirow, 1995), recent scholarship points to a wide variety of approaches to adult learning. For example,

approaches grounded in critical theory might include gender and spirituality (Tisdell, 1993, 2000), race (Shore, 2001), and class (Freire, 2000), focused on addressing issues of power and preference (Welton, 1993, 2001) through the ideal conditions for reflective discourse laid out by Habermas (1984), comprehensibility, sincerity, truth, and legitimacy (Habermas, 1984; Merriam, Caffarella, & Baumgartner, 2007). "Given our multiparadigm perspective, we believe it would be useful for theory building to be viewed not as a search for the truth, but as more of a search for comprehensiveness stemming from different worldviews" (Gioia & Pitre, 1990, p. 587). These additional models may inform while they may not drive the research paradigm used for this theory-building research study.

This study focuses on deriving relationships and generalizations from the adult learning theories of Knowles and Mezirow, technology adoption models, and professional learning models in an effort to uncover universal principles. As such, this study will focus much less on the critical theories of Tisdell, Shore, Freire, and Welton, thus the functionalist approach seems to be most appropriate. And, while Dubin recognized the value of different research paradigms his theory-building research method favors the functionalist paradigm.

Selecting the overall approach comprises the second step in determining a theory-building research process. Based in part on descriptions by Francis Bacon, Reynolds (2007) identified two basic theory-building approaches that he labeled research-then-theory and theory-then-research. The first, research-then-theory, involves a four-step process:

1. Select and list all of the characteristics of a phenomenon,
2. Measure all of the characteristics of the phenomenon in different situation,
3. Analyze the resulting data to search for patterns, and

4. Formalize the patterns as theoretical statements or laws.

Reynolds pointed out that, because this approach requires measuring all of the characteristics of the phenomenon, using this method requires two conditions: one a small number of variables and two, a small number of causal relationships between them. Reynolds then asks the obvious question, does this four-step process and its conditions match the needs of most social sciences research situations? In bold capital letters he provides an unambiguous one-word answer: "**NO**" (p. 143). The very large number of possible variables in most social science research situations makes this approach difficult, he argues.

Reynolds does go on to allow that researchers still use the research-then-theory method and that it reflects two beliefs about science and nature:

1. That there is a 'real truth' to be discovered in nature, in the form of discoverable patterns or regularities, and
2. That scientific knowledge should be organized as a set of laws, reflecting the 'real truth'" (Reynolds, 2007, p. 144).

Reynolds also allows for the power of computers to analyze large quantities of data. This ability may make possible the examination of a large number of variables and causal relationships, thus solving one of the conditions of the research-then-theory method.

Reynolds described the second theory building approach, theory-then-research, as a five step process:

> (a) develop a theory in either axiomatic or process form, (b) select a statement from the theory for comparison with empirical research results, (c) design a research process to test the relationship between the statement and the empirical data (d) if the

> statement does not correspond with the research make changes in the theory or the research process and repeat from step 2, and (e) if the statement does correspond with the theory test another statement or define the limits of the theory (Reynolds, 2007, p. 146-147).

A question arises around which statements to test, those most likely to be found to be true, those most likely to be found to be false, or the most crucial statements. Good research should make the theory stronger, explained Reynolds, therefore testing the most crucial statements, and perhaps those most likely to be false makes more sense than testing the statements that are most likely to be found true (Reynolds, 2007).

Regarding which approach to use for this study, Lynham's (2002b) general method of theory-building research allows for the use of both theory-building strategies described by Reynolds, that is, research-to-theory and theory-to-research. Dubin's (1978) method, more structured in sequence and parameters, generally requires a theory-to-research approach.

Having determined that the research paradigm (functionalist) and research approach (theory-then-research) fit the needs of the this study one might next turn to making a choice as to which research strategy to use (Lynham, 2002a; Torraco, 2002). Conducting research in theory building for the applied sciences requires two types of expertise. One, the researcher-theorist must possess deep knowledge about and experience with the phenomenon to be investigated. Two, the researcher-theorist must understand and apply a theory-building research strategy (Lynham, 2002b; Storberg-Walker, 2003). Chapter Two of this study, the review of literature, provides access to knowledge about the phenomenon, that is, the possible impact of adult learning principles on educator technology adoption models and

educator professional learning. The author of this study has worked in this field of education as an educator, technology consultant, and professional developer for 26 years, conducting and applying research, and acquiring a deep insight and level of experience. The following section describes a process for the theory-building research process.

Lynham (2000) argues that although others proposed sound processes for a variety of theory building methods, including case study (Eisenhardt, 1989; Stake, 1995), grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990), interpretive theory (Van Manen, 1990), action learning theory (Marsick 1990; Mott, 1996), these methods have been "difficult for the HRD researcher to access and replicate" (Lynham, 2000, p. 166), thus making their utilization problematic. Upton and Eagan (2010) argue for a multilevel theory building approach in HRD, referencing the works of Kozlowski and Klein (2000), Morgeson and Hofmann (1999), and Reynolds-Fisher (2000). Replicating this method may also prove challenging. While all of these research strategies certainly contribute to theory-building research, the theorist should also ensure that the resulting research is accessible and applicable to HRD researchers and practitioners. Garcia, 2008; Storberg-Walker, 2004; Tuttle, 2003).

This section provides a framework for a theory-building research. Because of the structure and detailed description provided, Dubin's (1978) theory-building methodology provides a usable and functional starting point for a theory-building research project.

Dubin approached his theory-building research method from a hypothetico-deductive approach to knowledge construction (Dubin, 1976, 1978; Lynham, 2002a), and used the theory-to-research strategy described by Reynolds (2007) for theory development. Dubin's

method divides into two parts, one as the theory development side and a second as the operation and research side (Dubin, 1978; Lynham, 2002a; Toracco, 2000). This clear distinction forms a simple cycle of theory-research that may be repeated on an ongoing basis as a way of strengthening the theory (Lynham, 2002a).

Each of the two parts of Dubin's method includes a total of eight specific steps. Completion of the first four steps results in a conceptual framework of the theory. Completion of the second four steps results in an empirically verified theory. Lynham thought that these eight steps comprised a complete theory-building research model, writing, "Following the form and substance of this two-part theory-research cycle and eight-step applied theory-building method is considered necessary and sufficient to ensure both rigor and relevance in the resulting theory" (2002a, p. 244).

Toracco (2000) pointed out that although theorists must consider the entire model, "theory building and empirical research are often separated, and each of these is conducted as a distinct research effort" (2000, p. 41). Lynham (2002a) explained that the fifth step in Dubin's method, specifying the propositions, completes the theory-building phase and bridges to the research operationalization phase. Propositions are truth statements based on the explanatory and predictive nature of the theory uncovered in the first four steps or development phase. Agreeing with Lynham suggests that this is the place where the researcher-theorist ends the theory-building process. The research-verification phase of Dubin's method may be conducted by the original researcher-theorist or by others who wish to confirm or disconfirm the explanatory and predictive properties of the theory (Lynham, 2002a).

Garcia (2008) provides a clear example that uses the steps of Dubin's model to create a theory-building research framework. The model, shown in Figure 24 portrays Dubin's model as a series of steps, categorized by three main areas of the theory-building research process, conceptual development, operationalization, and confirmation/disconfirmation and application. Garcia also provides entry and exit points for his study. After using steps one through four of Dubin's model to develop a consistent conceptual framework, then operationalizing the theory by identifying propositions, Garcia identifies empirical indicators, develops a research hypothesis and exits the theory-building research process (Garcia, 2008). Similar to Holton and Lowe (2007), Garcia leaves for other researchers the actual testing of his theory and provides support from other researchers who support this type of methodology (Chenhall & Chermack, 2010; Storberg-Walker, 2004; Tuttle, 2003). Figure 24 provides an easy to access visual model of how to apply the theory-building components of Dubin's methodology.

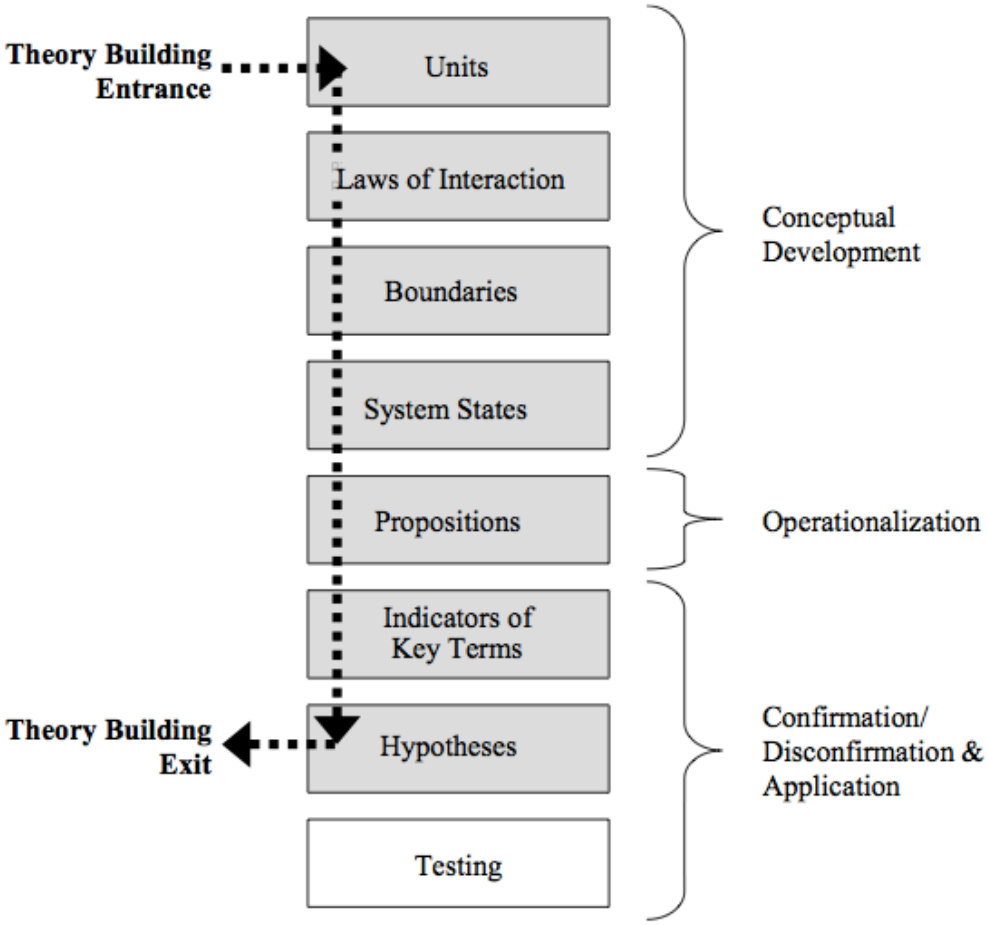


Figure 24. Garcia's entry-exit plan for using Dubin's theory building model. From Toward a social network-based theory of large-group interventions (Ed.D.), by S. K. Garcia, 2008, North Carolina State University, Raleigh, NC.

While Dubin's model represents a research building methodology, Holton and Lowe (2007) asserted that it does not define a research process. They developed a seven-step research process for using Dubin's theory building model. Their process exits the 8-step Dubin model after its step five, defining the propositions (step four in the Holton and Lowe model).

1. Conduct research to understand the phenomena and formulate the study.
2. Identify studies for an expanded review of literature.
3. Determine concepts and analyze relationships from the literature.
4. Create a theory. Define its units, laws of interaction, boundaries, system states, and propositions.
5. Evaluate the theory, using a team of scholars and Patterson's (1986) criteria.
6. Analyze and synthesize the feedback from the team of scholars.
7. Modify the theory. (Holton & Lowe, 2007)

The Holton and Lowe model provides a start to finish research process for theory building. The model could also be considered iterative, that is, that the last step, modify the theory, might also lead researchers back to steps one-six. Step four of the Holton and Lowe process equates to steps 1 to 5 of Dubin's methodology. The Holton and Lowe model adds specific steps for evaluating the theory using Patterson's (1986) criteria and a team of scholars that applies Patterson's evaluation model theory and provides feedback. According to the Holton and Lowe model, the researcher analyzes the feedback and makes modifications to the theory as appropriate.

According to Patterson (1986), theories must be tested to determine validity on an ongoing basis. The eight formal criteria Patterson describes provide a framework with which to make judgments about a theory. The theorist should consider the criteria as goals toward which to work, he cautions, because few if any theories meet all of the criteria (Patterson, 1986).

(1) Importance: a theory should apply real life or behavior and to broader situations.

(2) Preciseness and Clarity: a theory should be consistent and apply data, practice and the formation of research hypotheses.

(3) Parsimony or simplicity: a theory should remain as simple as possible without oversimplifying.

(4) Comprehensiveness: a theory should be broad and complete even if areas of interest may be more constrained.

(5) Operationality: a theory should be able to be converted to measurable and thus, researchable concepts. Not all concepts of a theory need to be convertible, as some describe relationships among other concepts.

(6) Empirical Validity or Verifiability: a theory should convert to measurable concepts, creating a pathway that uses experience and experimentation to determine a theory's truthfulness. This construction of new knowledge in verifying a theory also includes the knowledge gained through disconfirmation of the theory.

(7) Fruitfulness: a theory should have the capacity to lead to predictions or provoke new thinking, perhaps even as alternative or opposing theory.

(8) Practicality: a theory should be usable and apply principles in a practical way (Patterson, 1986).

One outcome of evaluating a theory may lead to complications between theories, or in the Holton and Lowe (2007) model, the analysis by a scholarly group may lead to the need to modify a theory. Van de Ven (1989) asserts that, "inconsistencies and contradictions between theories provide important opportunities to develop better and more encompassing theories" (p. 488). Van de Ven also suggests four ways to use the paradoxes between theories as a source for improving theories, including using the paradox as a learning moment, making sure the boundaries of opposing theories refer to parallel levels, examining time as a factor, and exploring new theories that dismiss the paradox (Van de Ven, 1989).

Choosing the functionalist paradigm from Burell and Morgan (1979) provides a clear starting point for theory building that leads to the theory-then-research approach described by Reynolds (2007). Using Dubin (1978) for a methodology in theory-building research provides a clear process on the intricacies of theory construction. Inserting into the model Patton's (1986) evaluation criteria provides a rigorous procedure to determine the value of the theory. Finally, Garcia (2008) and Holton and Lowe (2007) provide examples of using the Dubin model in the theory-building process that will guide this study.

This study will use the first four stages of Dubin's model, units, interactions, boundaries, and system states to develop new theory about the application of adult learning principles to technology adoption and educator professional learning models. After developing the theory the next step will be to develop researchable propositions. Applying Patton's evaluation criteria provides a model to assess the viability of the resulting theory.

This methodology addresses the purpose of this study, to use adult learning theory to conceptualize a broader theory of educator professional learning and technology adoption,

and to develop a framework that operationalizes the theory. The results will provide answers to the three research questions:

(1) Can adult learning theory be used to develop a theory of educator professional learning for technology adoption?

(2) Can adult learning theory be used to conceptualize a theory of educator professional learning for technology adoption?

(3) Can an adult learning based theory of educator professional learning for technology adoption be operationalized?

## Theoretical Framework

This study relies on Dubin's (1976) 8-step process for theory building. Dubin's method divides into three main areas, conceptualizing the theory, operationalizing the theory, and analyzing research on the theory. This study uses Dubin's 8-step process for theory building and the 17 years of experience of the researcher-theorist in delivering technology professional development to educators to develop a theory of educator technology adoption. This theory-building method has been described by Dubin (1978), Lynham (2002), Holton and Lowe (2007), and Garcia (2008). The findings of this study will show results in the two areas of Dubin's theory-building method, conceptualizing the theory and operationalizing the theory. This study will not conduct or analyze research on the theory, rather leaving that research for future studies.

## Conceptual Framework

Examining technology adoption models opens a discussion about ongoing efforts to understand how and why educators adopt and use technology in support of teaching and learning. This naturally leads to an examination of professional learning models and the connection of professional development practices to technology adoption. Both the technology adoption models and the professional development models include elements of adult learning theory but this inclusion seems more ad hoc than planned or intentional. Thus, a gap exists in the current technology adoption and educator professional development for technology models in the area of including adult learning theory. Examining adult learning theory opens a pathway for an approach to educator learning and technology adoption that purposefully utilizes adult learning principles. This study examines the gap and uses theory-building research techniques to create a new adult learning-based theory of educator professional learning and technology adoption.

# CHAPTER FOUR

# THEORY BUILDING

Creating the adult learning-based theory of K12 educator professional learning for technology adoption involves modeling processes at work in a technology-supported learning implementation in a K12 environment. This theory focuses on how K12 educators learn to adopt and adapt technology into their teaching and learning practices. Adult learning theory anchors the premise of this theory-building research process, providing new insight into how K12 educators might prepare and be supported as they learn about using technology for teaching and learning.

This chapter tests a set of ideas about adult learning theory, K12 educator professional development, and technology adoption models against Dubin's theory-building process (1978) resulting in a new theory, the adult learning-based theory of K12 educator professional learning for technology adoption. Units of the theory will be identified and defined using Dubin's model, as will the ways in which the units interact. Using Dubin's methodology to outline boundaries of the model and the system states for which it applies closes out the theory-building process. This work will answer the first two research questions: 1) Can adult learning theory be used to develop a theory of educator professional learning for technology adoption? 2) Can adult learning theory be used to conceptualize a theory of educator professional learning for technology adoption?

Dubin (1978) divides the theory-building research process into eight steps. The first four steps, units, laws of interaction, boundaries, and system states, that comprise the theory building section of the model are the focus of this chapter. The last four steps, propositions,

empirical indicators, hypotheses, and research, cover operationalizing and researching the theory (Dubin, 1978).

The building blocks for the adult learning-based theory of K12 educator professional learning for technology adoption come from areas of adult learning, K12 professional development models, and K12 technology adoption models. Units for the theory will be defined using the adult learning theories of andragogy, transformative learning, and other areas of the adult learning theory panorama. There is a natural fit for applying adult learning theory to K12 educator professional development, as explained by King (2002): "Viewing professional development as adult education assists in not only focusing on the educator as learner, but also enabling us to consciously appropriate relevant theory, research, and practice from the adult education field" (p. 284).

The adult learning-based theory of K12 educator professional learning for technology adoption uses units focused on context, environment, readiness, transformation, and implementation. The units on context and environment will be further divided to distinguish unique values around personal context, interpersonal context, the physical environment, the digital environment, and the policy environment. Laws of interaction will be developed to describe how the units interact, which will also define the boundaries of the theory.

These defined units and their interactions will be examined in a system state comprised of the relative interactions between three human components in K12 professional development, the institution or district as represented by administrators, teachers engaged in formal learning to support technology implementation, and the facilitators who support the professional learning.

The next section focuses on an explanation of Dubin's (1978) use of units in his theory-building research model followed by a description of each unit. The units will be generally defined, classified according to Dubin's research-building model, and logically tested for their integrity and usability in the adult learning-based theory of K12 educator professional learning for technology adoption.

## Units of the Theory

Dubin (1978) writes about units on two levels, at the conceptual level and at a much more specific level. At the conceptual level units form the building blocks of a theory. Like concepts, units may address large or small ideas, but they must be analyzed to understand how they fit together to form theories. Dubin provides examples of how units might be used in this series of fill-in-the-blank phrases: "_____ is the antecedent of _____, or _____ varies with _____, or _____ is a function of _____ or, if _____ then _____ with a probability of X" (Dubin, 1978, p. 40). The specified items asked for in the blanks of these examples are units. Units may be thought of as concepts defined by relationships. Combining units together and defining the way they interact with each other defines a theory (Dubin, 1978).

On a more specific level Dubin describes unit characteristics in either/or terms. He begins by distinguishing units from events where events describe a single occurrence and units hold true across multiple occurrences. For example, causes of the Civil War describes one event, whereas studying causes of war might cause a theorist to use war as a political relationship as a unit of a theory that would hold true across all wars about the causes of war (Dubin, 1978).

Dubin (1978) describes units as either attribute or variable. In attribute units the characteristic either exists or not (gender) and variable (height) where the characteristic exists in degree. Attribute and variable units provide different capabilities of what the theory can measure. Dubin acknowledges that many believe variable units are more precise regarding measurement but he prefers not to limit theory-building possibilities at this point (Dubin, 1978).

Dubin (1978) describes other distinguishing either/or features of units, including real (empirical indicators are consistent) or nominal (empirical indicators are not consistent) units, primitive (can not be defined) or sophisticated (can be defined) units, and collective (a group or class) or member (individual members of a set) units. Although it is possible to use both collective and member units in a theory, Dubin generally discourages using collective units to predict the behavior of a member unit (Dubin 1978).

Dubin goes beyond either/or types of units to discuss the following five classes of units: enumerative, associative, relational, statistical, and summative (EARSS). In enumerative units the property of the thing is always there (age). In associative units the property is there under certain conditions. Therefore, an associative unit may have a non or zero value (income). Relational units depend on the relationship between two other properties (sex ratio is dependent on the interaction between the number of males and females). Statistical units summarize the distribution of the property and, although these are sometimes difficult to define, summative units comprise multiple properties (Dubin, 1978). Complex units may meet the requirements for more than one class of unit.

Dubin lays out several prohibitions on combining certain classes of units.

- A relational unit is not combined in the same theory with enumerative or associative units that are themselves properties of that relational unit.
- Where a statistical unit is employed, it is by definition a property of a collective. In the same theory do not combine such a statistical unit with any kind of unit (enumerative, associative, or relational) describing a property of members of the same collective.
- Do not draw conclusions from only one portion of the empirical relationships found.
- Summative units have utility in education of and communication with those who are naïve in a field. Summative units are not employed in scientific models. (Dubin, 1978, pp. 73-78)

Dubin goes on to debunk the condemnation assigned to descriptive research. Descriptive research plays an important role in early stages of theory development. "Descriptive research is the stuff out of which the mind of man, the theorist, develops the units of that compose his theories" (Dubin, 1978, p. 87).

## Unit One: Technology Implementation in K12 Education

The key indicators for the unit technology implementation in K12 education are technology implementation, K12 education setting, and educator professional learning to support technology adoption. This unit is a catalyst unit, the presence of which triggers the laws of interaction between the units of the adult learning-based theory of K12 educator professional learning for technology adoption. The section includes a scenario that provides a

narrative for this unit and the other units of the theory followed by a discussion of the theory-building research logic for this unit.

The following scenario describes a fictional district implementing technology and engaging teachers in professional learning to support the implementation. The scenario puts into context elements of professional learning to support technology adoption as described in Chapter Two and illustrates how the units of the adult learning-based theory of K12 educator professional learning for technology adoption interact in a K12 technology implementation. The scenario identifies the following eight units. The units will be placed in backed capital letters in the scenario as a way of pointing out how the units interact.

**Unit One**: Technology Implementation in K12 Education
**Unit Two**: Personal Context
**Unit Three**: Physical Environment
**Unit Four**: Digital Environment
**Unit Five**: Policy Environment
**Unit Six**: Interpersonal Context
**Unit Seven**: Readiness to Learn
**Unit Eight**: Transformative Learning

## A K12 Education Technology Implementation Scenario

The River City School District (RCSD) recently completed a revised mission statement that calls for educators and students to engage in world class teaching and learning, using 21st century skills to support students becoming and college and career ready. The district leadership team that worked on the mission statement, consisting of administrators, teachers, parents, and community members, went on to identify key documents that help define 21st century skills including the 21st Century Skills document from the Partnership

for 21st Century Skills (P21) and the National Education Technology Standards (NETS) from the International Society for Technology in Education (ISTE, 2007, 2008; P21, 2007).

RCSD consists of sixteen elementary schools, six middle schools and six high schools. At approximately 19,000 students this makes RCSD the third largest school district in the state and classified by the National Center for Educational Statistics as a large suburban district located in an area with a total population of 250,000 or more (Keaton, 2012). The district employs approximately 3,200 full and part time staff members.

To transform teaching and learning and realize its mission statement RCSD plans to distribute tablet devices to every teacher and student, starting with distribution to teachers in January 2015, and followed by distribution to students in August 2015 [UNIT ONE: TECHNOLOGY IMPLEMENTATION IN K12 EDUCATION]. Naming the project, *Learning Now*, RCSD will create a professional development program that prepares educators to leverage the new technology to help students succeed and provides ongoing support as the project moves through various phases.

The district organized a Learning Now Project Team (LNPT), chaired by the district director of staff development, reporting directly to the district superintendent, and tasked with development and implementation. The LNPT will leverage internal district resources as well as external expertise where appropriate. To facilitate teacher and student exploration of how to use the technology in classrooms the district will provide each school with a cart of 40 tablet devices to be used during the spring of 2015 in conjunction with the beginning of the professional development program. With a goal to transform teaching and learning, teachers will learn strategies during professional development, test them with students using

the carts, and redefine their practices in preparation for when all learners have full time access to mobile digital tools in the fall of 2015 [UNIT EIGHT: TRANSFORMATIVE LEARNING].

### Professional Development Scenario: Part Two

At the River City School District (RCSD), the *Learning Now* project team (LNPT) continues planning for its professional development program. The team uses the alignment of the adult learning conditions and processes with the components of the Interactive Program Planning Model in Figure 25 to chunk some of the planning steps, thus applying theoretical constructs of adult learning to the planning process. Caffarella (2002) makes clear that the steps need not be completed in any particular order so this method helps members of the planning team focus on different areas. Knowing how the Caffarella components specifically relate to adult learning helps the LNPT members adjust their planning. For example, the person coordinating facilities, scheduling, marketing, and budgeting will focus on making the overall environment of the professional development comfortable warm, inviting, flexible, fun, and respectfully professional [UNIT THREE: PHYSICAL ENVIRONMENT. The Information Technology department will ensure that all tablets issued to teachers (and later to students) are fully functional, connected to the district wireless infrastructure, and updated regularly using mobile device management software [UNIT FOUR: DIGITAL ENVIRONMENT]. District administrators will review district policies such as the acceptable use of technology policy and the other district-required professional learning initiatives to ensure that district policies support the implementation and do not place unrealistic demands

on teachers. The LNPT also wants to ensure that teachers have enough time to engage in the professional development and test new ideas [UNIT FIVE: POLICY ENVIRONMENT].

District leaders will engage teacher leaders, district facilitators, and principals in making intentional the process of individuals discerning their personal learning needs, and building a base of support for the project UNIT TWO: PERSONAL CONTEXT. Prior to distributing devices to teachers the LNPT plans to administer a pretest survey to all district employees that measures perceptions about the usefulness, the ease of use of technology, the organizational culture and the collective sense of efficacy of the teachers for implementing new and transformative practices. The survey also measures specific skills around using technology to support teaching and learning, thus serving as a learning needs-assessment. Results of the survey will be shared with individuals and used by the LNPT in planning professional development. The LNPT plans to administer the survey as a posttest at the end of each year. This planning will focus on helping participants understand what it means to be an adult learner (as opposed to a student learner), the project timeline for implementation with students, and how this project will impact the way participants work on a daily basis (thus helping participants to develop their status as adult learners and explore their need to learn). Figure 25 shows how the district leaders combined elements of Caffarella's (2002) planning model with the conditions and processes of adult learning [UNIT SEVEN: READINESS TO LEARN].

| Conditions and Processes of Adult Learning | Components of the Caffarella Interactive Program Planning Model (2002) |
|---|---|
| Condition: Environment | Coordinating facilities and on-site events<br>Selecting formats, schedules, and staff needs<br>Preparing budgets and marketing plans |
| Condition: Status | Discerning the context |
| Condition: Readiness | Building a solid base of support |
| Condition: Planning | Identifying program ideas<br>Developing program objectives<br>Sorting and prioritizing program ideas<br>Formulating evaluation plan |
| Process: Critical Reflection | Designing instructional plans |
| Condition: Performance<br><br>Process: Work with Frames of Reference<br>Process: Dialogue to Re-frame | Devising transfer-of-learning plans |
| Condition: Reflection | Making recommendations and communicating results |

Figure 25. Adult learning conditions and processes and elements of the Interactive Program Planning Model. Adapted from, Planning programs for adult learners: A practical guide for educators, trainers, and staff developers, by R. S. Caffarella, 2002, San Francisco: Jossey-Bass, and "Transformative learning: Theory to practice," by Jack Mezirow, 1997, New Directions for Adult & Continuing Education, 74(5), and The adult learner. The definitive classic in adult education and human resource development, by M. S. Knowles, E. F. Holton, III and R. A. Swanson, 2005, (6th ed.), Burlington, MA: Elsevier

After several planned informational and focus group meetings and a needs assessment survey with district educators and community members, the project team develops a plan for professional development for the *Learning Now* project. Highlights of the plan include the opportunities for all stakeholders as well as focused offerings for four key groups: leadership, lead teachers, teachers, and community.

All educators in the district will attend a 3-hour getting started training upon receiving their tablet device. All educators will have access to an online library of tutorials, technology tips and tricks, shared best practices, and research about implementing tablet devices in schools. All educators will be invited to participate in ongoing webinars around various topics developed by the district and as specific need arises.

Leadership professional development, for building and district administrators, will focus on presenting a common district voice, providing ongoing support for teachers, students and community, and helping to assess and communicate what it will mean to achieve success in this project. To support this they will attend monthly 3-hour project meetings where they will share ideas and learn new strategies. Lead teachers, consisting of approximately 15% of the faculty and including department heads, opinion leaders, and the tech-savvy, will engage in a series of 1-day workshops four times each school year.

During the workshops they will learn new skills, work collaboratively to create and share plans for implementation and share results from previous implementation. Lead teachers will share their experiences with other teachers in an informal coaching model. All teachers will participate in weekly team planning meetings focused on learning sharing skills and strategies where lead teachers may act in a coaching role. Parents will participate in a 90-minute technology training at the rollout for devices. The district will offer ongoing learning for parents and community through "tech nights" to be sponsored monthly and hosted by four different schools each month. The plan will be reviewed twice a year by the project team with input from each school so that adjustments might be made to accommodate new and ongoing circumstances [UNIT SIX: INTERPERSONAL CONTEXT].

This scenario describes a K12 technology implementation that provides ubiquitous access to tablet for teachers and students in support of the district's mission to apply 21st century teaching and learning skills to prepare all students for college and career. The implementation requires tremendous effort of the part of all district employees to learn new skills and rethink current professional practices in order to achieve the mission. The scenario also provides a context for discussion of the adult learning-based theory of K12 educator professional learning for technology adoption.

The district's decision to distribute tablets to all teachers and students introduces the technology implementation as a learning stimulus, that is, a reason for educators to engage in an intentional, formal learning process that influences educational practice. In some cases the educators might be learning about how to use the technology, in other cases the learning might be about how to use the technology in support of the teaching and learning goals of the district. Although the limitations of the this study and the boundaries of the resulting theory specify a technology implementation in K12 education the model could possibly be extended to include other learning stimuli for K12 educators including, for example, implementing common core standards.

In this scenario the decision to move forward with the technology implementation causes the educators involved to engage in a learning process. The technology implementation, then, becomes the first unit of in the adult learning-based theory of K12 educator professional learning for technology adoption. Dubin (1978) called this type a catalyst unit. This unit, called technology implementation in K12 education, impacts the other units in the model by its presence, meaning that if and only if the unit called technology

implementation in K12 education exists in some form or value, then the laws of interaction between the other units exist (Dubin, 1978). Certainly the other units may exist in a model and interact without the presence of the unit entitled technology implementation in K12 education, but that is outside the scope of this study.

## Theory-Building Research Logic

The Technology Implementation unit in K12 Education creates the learning stimulus that compels the participants in the model (i.e, teachers, administrators and facilitators) to engage in professional learning to support technology adoption. Without some type of technology implementation, the participants of the system would not all participate in professional learning to support technology adoption. Dubin (1978) refers to this type of unit as a catalyst unit which may be of any type in Dubin's EARS units. The character of a catalyst unit matters less than the way in which it interacts with other units. In social science the most common law of interaction between a catalyst unit and two other units is, if and only if the catalyst unit exists, then the other units interact (Dubin, 1978). That is the case for all of the units in the adult learning-based theory of K12 educator professional learning for technology adoption.

This unit, technology implementation in K12 education, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). It is a collective unit, consisting of the participants in the system. Because technology implementation in K12 education is an enumerative unit, meaning the properties of it always exist in the system, and an attribute unit, meaning that it either exists or it does not, this unit always exists in the system (as opposed to conditions where it would not exist, not allowed for an enumerative

unit). Dubin (1978) goes on to say that sometimes in such cases, "by its very presence, it can become the shorthand identifying tag for the entire thing" (p. 59). Indeed, many would frequently refer to the unit technology implementation in K12 education when they meant the entire system. Finally, because it is a catalyst unit, it must exist in order for the laws of interaction between the other units of the theory to exist (Dubin, 1978).

Other units in the model include: personal context, interpersonal context, physical environment, digital environment, policy environment, readiness to learn, and transformative learning. Each of the units, personal context, interpersonal context, physical environment, digital environment, and policy environment should be read with the phrase conducive to learning at the end. This is to indicate that the values of these units increase as the indicators of the unit provide positive support for K12 educator learning in a technology implementation. The scenario featured each of these units. Figure 26 illustrates the relationship between the units in the adult learning-based theory of K12 educator professional learning for technology adoption. In Figure 26, the darker gray box, technology implementation in K12 education, represents a catalyst unit and affects all other units. The light gray box, personal context, represents a unit that provides input to every other unit (except technology implementation in K12 education. The white box, professional learning, is not a unit, but is, rather the output of the three units contained therein.

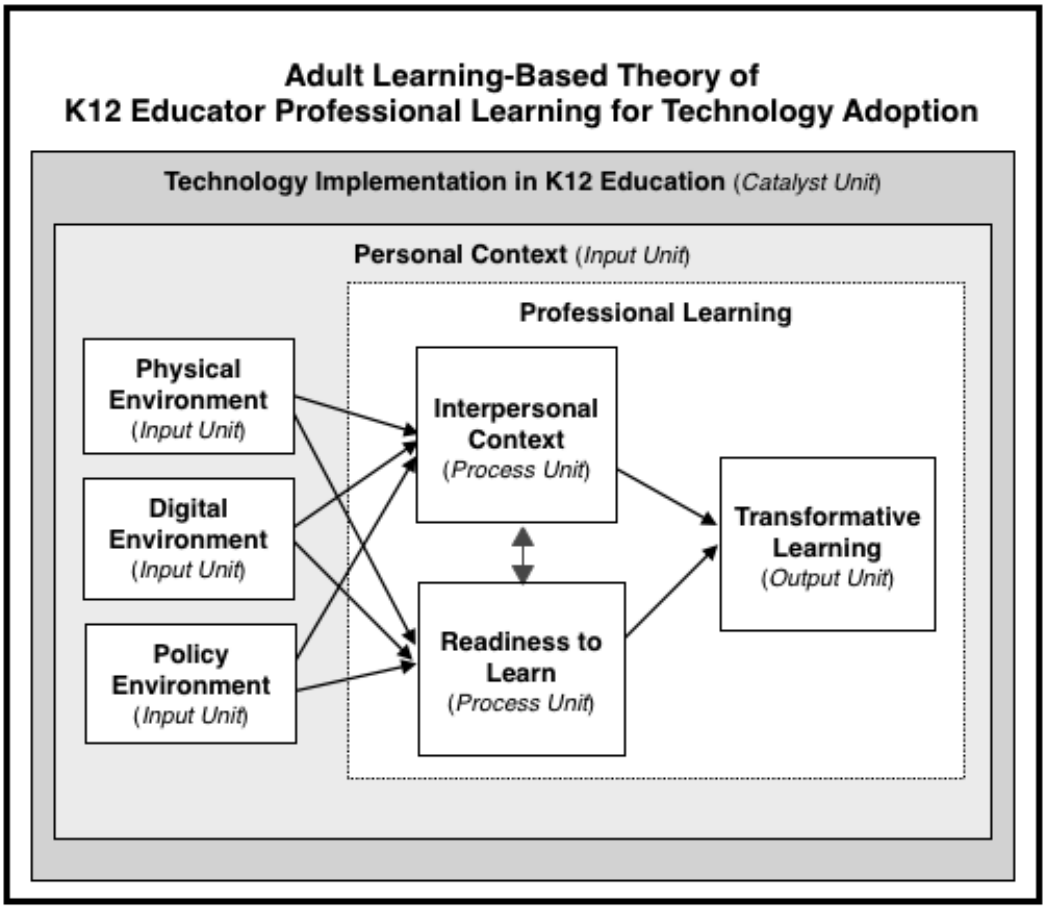


Figure 26. Units in the adult learning-based theory of K12 educator professional learning for technology adoption.

## Context in Adult Learning

This section describes the impact of personal and interpersonal context on the adult learning-based theory of K12 educator professional learning for technology adoption. Likewise, personal and interpersonal context, the topics of the next two units, refers to the teachers, administrators and facilitators as participants in the system. A description of the two units follows a general description of the importance of understanding and applying context in adult learning.

One way to define adulthood is the act of taking responsibility for a variety of roles in life such as employee, spouse, voter, provider, and parent (Knowles, 1973; Merriam, et al., 2007). Where children are largely dependent on others to determine their roles, life situation and well being, adults manage these for themselves. Learning may progress in a like manner. Children exist in home and school environments where they learn how to be adults, how to take responsibility for their actions and eventually assume new roles. Children engage in school full-time and adults control the curriculum that children follow in their school and home lives. Adults balance their own learning against the other roles for which they are responsible, and their individual contexts impact this balance on an ongoing basis (Merriam, et al., 2007). Since the 1990s theorists and researchers have brought more systematic attention to the importance of context in adult learning in two ways.

The first is the notion that learning is a product of the individual interacting with the context. Recent theories of situated cognition, reflective practice, and cognitive development are representative of this interactive view. A second way to view the importance of context in learning is to consider how the structures and institutions of society affect learning. These structural dimensions include factors such as race, class, gender, cultural diversity, and power and oppression. (Merriam, et al., 2007, p. 427)

Knowles (1973) begins his explanation of a human or psychological learning environment as one that encourages, recognizes, and rewards self-improvement. He moves on to describe a climate of psychological orderliness where goals, expectations, and opportunities are clearly defined, open feedback occurs regularly, and experimentation abounds. Knowles encourages educators to “create psychological climates experienced by

the individuals in them as safe, caring, accepting, trusting, respectful, and understanding" (p. 107). To this list of adjectives describing interpersonal context Knowles adds with emphasis, "collaborative" (p. 107). The facilitator should help learners get to know each other in a casual and comfortable way, valuing and respecting the input of each individual. Doing this helps to create an environment in which all participants feel that they may participate in the way they learn best (Knowles, 1980a).

Taylor and Snyder (2012) conducted a critical review of research on transformative learning and noted the many influences of context on adult learning theory building and research. These contextual influences could be used as an additional lens through which to view transformative learning, and include the interacting contexts as well as the structural contexts referred to previously (Merriam, et al., 2007). Examples of interactive contexts examined by Taylor and Synder (2012) include informal and formal learning, cross-cultural, spiritual, social justice and equity, and personal relationships. Examples of structural contexts examined by Taylor and Snyder (2012) include race, gender, sexual orientation, age, and economic status.

Contextual factors influence andragogy as well as transformative learning, providing at the very least an enlightening lens through which to achieve greater clarity around adult learning and more realistically a set of criteria that must be accounted for when planning for adult learning (Merriam, et al., 2007; Sandlin, 2005; Taylor & Snyder, 2012).

Using context as a unit allows for a broad inclusion of interactive and structural factors. For example, descriptive structural factors such as race, age, gender, and socio-economic background among those participating in a K12 technology implementation may

impact the course of technology adoption (Merriam, et al., 2007; Venkatesh& Davis, 2000; Venkatesh & Morris, 2000). Certainly other factors influence the course of technology adoption by educators, such as emotional factors, participants' attitudes towards the use of technology in the classroom, their perceived ability to learn technology, and their beliefs about the usefulness of technology (Venkatesh & Bala, 2008; Venkatesh & Davis, 1996, 2000; Venkatesh, et al., 2003). For the purpose of this study these factors will be included in the unit personal context.

Other interactive contextual factors such as issues of social justice and equity, relationships between participants, issues of politics and power, and collaboration also influence the course of technology adoption (Merriam, et al., 2007). For the purposes of this study these factors will be included in the unit interpersonal context.

Caffarella (2002) defines contextual factors in organizations into structural, political, and cultural factors. The contexts of the organization impact the learning in such areas as pressure to raise student text scores and mandated professional development requirements Caffarella, 2002). Structural contexts include, for example, district policies or master calendars that dictate professional development days and content. Political contexts include the way that power gets used across the institution and the impact of coalitions of power, both formal such as teachers' unions and informal (Cervero & Wilson, 1994, 2006). Cultural contexts may include traditions of the institution and organizational patterns such as a focus on service learning and hiring practices (Caffarella, 2002). For the purposes of this study the contexts Caffarella describes as political and the uses of power described by Cervero and

Wilson will be included in the unit called interpersonal context. The contexts that Caffarella describes as structural and cultural will be included in the unit called policy environment.

The descriptions of context in this section refer to a broad array of factors that influence adult learners. Contextual factors influence belief, beliefs are difficult to change and influence perceptions and judgment, and perceptions and judgment influence knowledge and practices (Bandura, 1977; Brown, 2006; Merriam, et al., 2007; Owston, 2007). Thus, context as a unit in an adult learning-based theory may include a wide variety of factors. This study divides contextual factors across three units to create the adult learning-based theory of K12 educator professional learning for technology adoption.

## Unit Two: Personal Context

The key indicators for the unit personal context are perceived ease of use of technology, perceived usefulness, experience, and voluntariness. Each will be discussed in detail and summarized, followed by a discussion of the theory-building research logic for this unit.

### Indicators of the Unit

A variety of factors make up the unit personal context. Teachers' professional behavior is related to their passions, personal history, ideals and life-missions. Teacher beliefs are rooted in how they were taught and these preconceptions are difficult to change (Hoekstra & Korthagen, 2011). Teachers' beliefs about good student learning and good teaching, shaped early in careers, influence teacher behavior around professional learning. A variety of personal contextual factors influence teacher learning including tolerance of

uncertainty, openness to change, perceived sense of self-efficacy, conscientiousness, and how teachers regulate emotions. (Van Eekelen, Vermunt, & Boshuizen, 2006).

The technology adoption models examined in Chapter Two provide direction on the personal context unit. The Technology Acceptance Model (TAM) and its various iterations, and the Unified Theory of Acceptance and Use of Technology (UTAUT) provide particular insight into how personal context impacts the adoption of technology (Venkatesh & Bala, 2008; Venkatesh & Davis, 1996, 2000; Venkatesh, et al., 2003). As discussed in Chapter Two, the authors of the Technology Acceptance Model explored how new aspects of personal context might impact the model(s) known as TAM, TAM2, or TAM3. TAM3 evolved out of TAM and TAM2 to explore how determinants at the individual level (personal context) might impact or be impacted by interventions (professional learning) to improve the intention to use and the actual use of technology (Venkatesh & Bala, 2008). Two determinants, perceived usefulness and perceived ease of use, and two moderators, experience and voluntariness, emerge as useful constructs for the personal context unit (Venkatesh & Bala, 2008). The authors identified four types of determinants of perceived usefulness and perceived ease of use: (a) individual differences such as demographic and personality traits; (b) system characteristics that influence personal perceptions regarding ease of use; (c) social influence, including social processes and mechanisms that influence individual perceptions about information technology (IT); and (d) facilitating conditions or organizational support for the use of IT (Venkatesh & Bala, 2008).

TAM2 (Venkatesh & Davis, 2000) identified determinants of perceived usefulness on behavioral intention of technology in two categories, social influence and cognitive

instrumental processes. The two determinants in the social influence processes identified in TAM 2 (Venkatesh & Davis, 2000) are subjective norm – what do others expect me to do, and image – the degree to which an individual believes that the use of IT will improve one's status in the social system. Three social influence mechanisms impact social influences: compliance, or doing what others want to attain rewards or avoid punishment; identification, or desiring to perform or behave a certain way because the individual thinks others expect it; and internalization, or internalizing another belief system into one's own (Venkatesh & Bala, 2008).

Venkatesh and Davis (2000) identified four determinants in the cognitive instrumental process of perceived usefulness: (a) perceived ease of use – that using an IT will be free of effort; (b) output quality – the user believes the IT can do the job; (c) job relevance – the user believes the IT is job relevant; and (d) result demonstrability – the user believes the results of using the IT are tangible and communicable. Ease of use and result demonstrability directly and positively influence perceived usefulness (Venkatesh & Davis 2000). In a K12 education technology implementation, the catalyst unit for this system, the idea of self-efficacy for the participants in the system would extend beyond the ability to use the technology to demonstrating the ability to use the technology with students in the classroom (Ertmer & Ottenbreit-Leftwich, 2010). This job relevance and output quality moderate perceived usefulness so that higher output quality results in stronger job relevance effect on perceived usefulness (Venkatesh & Davis 2000).

Venkatesh and Davis (2000) identify a second key determinant for the behavioral intention to use IT as perceived ease of use. Individuals form perceptions about ease of use

early in their experience with IT based on their beliefs about technology and technology use. Venkatesh and Davis (2000) identify three determinants of the individual characteristic: computer self-efficacy – a belief that one can be successful using computers, computer anxiety, and computer playfulness. They identify one facilitating condition – system support and reliability. Of these, computer anxiety and computer playfulness are moderated by experience (i.e., as users gain more experience using the system anxiety and playfulness may become less impactful). With experience, two additional system characteristics - perceived enjoyment and objective usability - become determinants Venkatesh & Bala, 2008; Venkatesh & Davis, 2000).

For the purposes of the adult learning-based theory of K12 educator professional learning for technology adoption, the TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008) models provide an excellent basis for determinants in the unit personal context. As Venkatesh and Bala (2008) point out, perceived ease of use and its determinants of computer anxiety, computer playfulness, and computer self-efficacy are individual types of determinants. Experience and perception of voluntariness – the extent to which the individual believes participation in using the IT is within one's control, moderate these determinants and brings along two additional individual determinants, perceived enjoyment and objective usability (Venkatesh & Bala, 2008). The cognitive instrumental determinants of perceived usefulness, perceived ease of use, output quality, job relevance, and result demonstrability also fit into the unit personal context (Venkatesh & Bala, 2008). These two determinants, perceived usefulness and perceived ease of use, along with the

moderators experience and voluntariness will be the key determinants and moderators of the unit personal context.

### Theory-Building Research Logic

This unit, personal context, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). Even though the unit includes the word personal in its title this is a collective unit, consisting of the combination of all the personal contexts of the participants in the system. It is a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Environment as Unit

Following an overview of a summative unit, environment, this section provides a more detailed description of the three units included in the adult learning-based theory of K12 educator professional learning for technology adoption, physical environment, digital environment, and policy environment.

Knowles (1973) defines the learning environment as the "quality of the climate of the organization," calling it, "the most crucial element in the whole process" [of human resource development] (p. 106). He divides his thinking about the learning environment into three parts, the physical, the human, and the organizational. The previous section on Unit Two focused on personal context and described part of what Knowles meant by the human learning environment (Knowles, 1973, 1980a). The organizational learning environment Knowles (1973) refers to how the constructs of the organization affect learning. Some of

these organizational constructs are more focused on rules, laws, policies and standards while other organizational constructs focus on the way that participants interact (Knowles, 1973). The interpersonal context unit addresses the way that participants in an organization interact, leaving the policy side unaddressed as a unit at this point. Add to this the digital learning environments required in technology implementations and a part of today's K12 educator professional learning programs (Oliver, et al., 2012). Three units on environment will be added to the adult learning-based theory of K12 educator professional learning for technology adoption, the physical, policy, and digital environments. For the purposes of brevity and clarity, and especially in graphical representations, at times these three units on environments may be portrayed as a single summative unit. Dubin (1978) allows for the use of summative units to increase understanding for those just learning about the units of a system (especially in the social sciences) even as he advises not to use them in the theory itself.

## Unit Three: Physical Environment

The key indicators for the unit physical environment conducive for learning are spaces, ambience, and equipment and materials. Each will be discussed in detail and summarized, followed by a discussion of the theory-building research logic for this unit.

### Indicators of the Unit

The physical environment conducive for learning begins with providing for human comforts in the space in which professional learning occurs, including barrier-free access to rooms of the proper size, windows and lighting, temperature and ventilation, noise and

acoustics, access to break rooms and restrooms, arrangement of furnishings and comfortable seating, access to electric outlets, and access to refreshments (Caffarella, 2002; Hartwig, 2000).

A second aspect of the physical environment concerns the ambience, or how the layout of the space promotes learning. Spaces and seating arrangements should promote learner collaboration and interaction where the focus is on each participant as a learner and not on the instructor. Indeed, the instructor should serve as a facilitator, supporting learning (Caffarella, 2002; Knowles, 1973, 1980a). While one's natural inclination might be to assign the responsibility for creating a physical environment to the administrators or facilitators (and Knowles generally does this), Knowles describes in some detail an example where his students took it upon themselves to improve the physical look of their classroom with color and light to alter the way it made them feel (Knowles, 1973). Knowles also suggests providing time for learners to feel relaxed (Knowles, 1973, 1980a).

One innovator's journey to consider the adult learning physical learning space came through considering the Reggio Emilia approach to early child-care learning spaces (Bentham, 2008). The Reggio approach highlights the attention to detail for children, including color, shape of the furniture, arrangement of objects on the shelves, encouraging "children to explore, imagine, create and see their learning as important" (Bentham, 2008, p. 78). Bentham realized that the Reggio school environment, above all else, valued the rights, needs and capabilities of those who use the space. Those ideas apply to adults as well. Just as we model teaching and learning strategies to teachers in hopes that they will use those strategies with their students, we should also model physical learning spaces for teachers

(Bentham, 2008). Ideas for remaking the physical space include local artwork on the walls, a ceiling-hung projector, softer lighting options, changing the look of the room by removing barriers to collaboration, exchanging institutional looking furniture for natural looking pieces (Bentham, 2008).

A third indicator of the unit is equipment and materials used by the participants in the system, the teachers, administrators and facilitators. Equipment includes computer resources such as laptops, tablets, desktops, projectors, network connectivity, content-specific tools such as electronic microscopes, and multimedia tools (Cottle, 2010; Kopcha, 2012; Lu & Overbaugh, 2009). Non-electronic resources include whiteboards, printed materials, books, sticky notes, name cards, and content-specific manipulatives (Knowles, 1973, 1980).

One must also understand that different situations require different approaches to providing for the physical environment. For example, some urban school settings require an awareness of and managing for the unique issues connected to location and safety (Alvarez, 2010). Another aspect of the physical environment is the location of the professional learning. Situating professional learning in the context of classroom practice engages participants in solving authentic problems in teaching and learning and presents different organizational challenges (Easton, 2008; Webster-Wright, 2008; Van Eekelen, et al., 2006).

All of the participants in the system may work together to influence the indicators in the unit physical environment. Certainly, administrators and facilitators would typically share responsibility for ensuring that system participants have the necessary spaces, equipment, and materials, and that the ambience promoted an environment conducive to learning. Thus their actions would have a high impact on the unit.

### Theory-Building Research Logic

This unit, physical environment, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). This is a collective unit, consisting of the combined effects of the physical environment on the participants in the system of K12 educator professional learning for technology adoption. It is also a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Unit Four: Digital Environment

The key indicators for the unit digital environment are access, connectivity, support, and virtual spaces. Access refers to access to the necessary digital tools such as computing devices, and ancillary tools such as projectors, cameras, and digital content. Connectivity refers to providing participants in the system access to the Internet on a continuous and on-demand basis. Support refers to providing help-desk and repair facility and long-term sustainability in ways that build user-confidence in the reliability of the digital environment. A discussion of the theory-building research logic for this unit follows a discussion of the unit's indicators.

### Indicators of the Unit

Implementing technology in K12 education requires planning across a broad array of connected issues that influence the creation of a digital environment. Technical and implementation problems or lack of adequate resources or assistance can create barriers to teacher use of technology and affect teacher motivation and buy-in towards the technology

implementation (Cottle, 2010; Lu & Overbaugh, 2009; Oliver, et al., 2012). Lack of access is also a barrier, and if the technology exists but does not work reliably access remains a barrier to implementing technology (Kopcha, 2012).

The issues that affect the digital environment include: access to technology, connectivity, digital content, technical support, sustainability, and the ethical use of technology (Oliver, et al., 2012). These areas must be addressed for students, teachers, and administrators (Anderson & Dexter, 2005). Those in leadership roles, mostly principals, facilitators, and district administrators, bear much of the responsibility of establishing and maintaining the digital environment although students and teachers and even community members sometimes participate (Anderson & Dexter, 2005; Brokmeier, Sermon & Hope, 2005)

A digital environment must also account for the school or district sponsored virtual learning spaces as well. Cercone (2008) used andragogy and transformative learning to develop a set of design principles and guidelines for adult online learning environments. Design principles include attention to the way things look such as easy-to-read fonts, graphics, images, clear menus, and multiple opportunities to practice and get help and feedback. Other guidelines include removing cultural bias, providing for self-paced and self-guided movement through activities and providing multiple resources and modes of content presentation (Cercone, 2008).

Virtual environments should seek to mirror the type of collaborative interaction found in professional learning communities (PLCs) and other forms of face-to-face teacher collaboration (McConnell, Parker, Eberhardt, Koehler, & Lundeberg, 2012). Virtual

environments become necessary when the key criteria for PLCs, that teachers meet together in real time to discuss challenges in teaching and learning, are not possible. Facilitated properly, video-conferencing, can be a reliable substitute for PLCs. Teachers must feel that they are in the present with other participants, and have a sense of trust and support in order to meaningfully engage in critical thinking (McConnell, et al., 2012). Among the factors that should be considered in the design of a virtual learning space are: "learning goals, communication tools, participant structures, and member responsibilities; the contextual factors are culture, politics, and economics" (Liu, 2012, p. 701).

The participants in the system interact together in the digital environment. Administrators and facilitators would typically share responsibility for ensuring that system participants have the access to digital equipment, on-demand connectivity, reliable support, sustainability for the digital environment, and access to virtual spaces. Thus their actions would have a high impact on the unit.

## Theory-Building Research Logic

Digital environment is a real and sophisticated unit because it can be defined by consistent, empirical indicators (Dubin, 1978). This is a collective unit, consisting of the combined effects of the digital environment on the participants in the system of K12 educator professional learning for technology adoption. It is a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Unit Five: Policy Environment

The key indicators for the unit policy environment are standards, policies, and practices. Each will be discussed and summarized, followed by a discussion of the theory-building research logic for this unit.

### Indicators of the Unit

Standards permeate the education landscape. Standards exist in every state for what students should learn in multiple subjects at every grade level, and what teachers and administrators should know and be able to do. ISTE (2007, 2008, 2009) provides standards for what students, teachers, administrators, technology coaches, and teacher educators should do with regards to the use of technology.

District administrators must consider the policies that support or obfuscate K12 educator professional learning for technology adoption. Examples of this include policies that dictate professional development time, constrain the ability of teachers to collaborate, new textbook adoptions, and testing pressures (Cottle, 2010; Lu & Overbaugh 2009). Teachers identify lack of time to learn and plan how to use technology in support of teaching and learning as a major barrier to implementation. Time was a barrier because using technology required more time to learn it and to plan to use it. Using technology also required more time to develop sound classroom management strategies Kopcha (2012).

Creating a policy environment conducive to learning falls into the responsibilities of school and district leadership. Examples include establishing a technology committee and shared vision, managing a technology budget, staff development policy, and acceptable use policies (Anderson & Dexter, 2005; Oliver, et al., 2012).

Knowles (1973) concludes his thoughts about the learning environment with a discussion about organizational climates. The placement of human resources development on the organizational chart indicates its relative importance. The organization's management philosophy and structure matters, too. A hierarchical top-down management approach may be less conducive to internally motivated self-improvement than a flatter organizational chart focused on working teams (Knowles, 1973). Organizations should be able to articulate how and why they support educator learning, the financial and human resources committed to support educator learning, and any appropriate policies or laws (Knowles, 1980).

Adams & Forsyth (2006) discuss enabling school structures that leverage the formalization, centralization, rules, regulations, and procedures to help teachers and to lead to problem solving, whereas "a hindering school structure forces conformity to rigid rules and regulations" (p. 634). Enabling school structures bring people together to create collaborative opportunities for collective problem solving, promoting trust, and creating a sense of ownership across the group. "Schools can configure their formal organizational structure so it produces the type of social networks and interactions necessary for efficacy formation. Or, inversely, school structures could hinder the existence of normative conditions that influence efficacy beliefs" (Adams & Forsyth, 2006, p. 640).

James and McCormick (2009) conducted a mixed methods study of over 1200 teachers in 40 schools on how teachers learning how to learn impacted students learning how to learn. Specifically, their research addressed the best methods to help prepare students to function in a 21st century of changing contexts of knowledge that requires the ability for teachers to continuously learn. The study a found positive relationship between supportive

leaders who create an environment to promote teacher risk taking and collaboration, teacher learning autonomy, and student performance. The study found an inverse relationship between restrictive school policies that focused on test scores, teacher autonomy, and teachers' ability to help students reach learning autonomy (James & McCormick, 2009).

Professional development can actually be a barrier to technology adoption if the activities do not focus specifically on areas meaningful to teacher practice or if the training focuses solely on the skills of using a technology (Kopcha, 2012). Teachers who understand the vision of leadership persist in using technology more than those who do not.

The participants in the system interact together in the unit policy environment. Administrators carry the primary responsibility for ensuring that the standards, policies, and practices implemented in the system promote professional learning to support technology adoption in ways that are conducive to learning. Helping all participants develop a shared vision for how technology should be used to support teaching and learning is critical. Thus the actions of administrators have a high impact on the unit.

## Theory-Building Research Logic

This unit, policy environment, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). This is a collective unit, consisting of the combined effects of the policy environment on the participants in the system of K12 educator professional learning for technology adoption. It is a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Unit Six: Interpersonal Context

The key indicators for the unit interpersonal context are leadership, organizational culture, and collaboration. Each will be discussed in detail and summarized, followed by a discussion of the theory-building research logic for this unit. This section also includes a discussion about how the use of power in human interactions might influence the adult learning-based theory of K12 educator professional learning for technology adoption.

### The Use of Power in Interpersonal Context

A good place to start a discussion about interpersonal context is understanding the nature of power. This study uses adult learning theory to inform K12 educator professional development for technology adoption. As such, the adult learning theories employed in this study carry with them an underlying assumption of one of the core purposes of adult education, to empower adult learners (Brookfield, 2001; Freire, 2000). Empowering adults raises the issue of power itself, who has it and how does it get used. Power may be viewed in at least two ways: one view argues that those who possess power (power given to them by the consenting masses) use it in oppressive ways to control others (Freire, 2000). A second view argues that power is not possessed, but rather that it is exercised (Brookfield, 2001; Foucault, 1980). This second view of power influences the way Cervero and Wilson (1994) explain the use of power in education programs for adult learners.

> Power is not a specific kind or relationship (such as one of domination) but is rather a necessary characteristic of all relationships…. Power relationships exist in all human interactions and define what people are able to do in a particular situation. … In sum,

> educational programs are constructed by people with particular interests who have relationships of power with each other. (p. 29)

Cervero and Wilson (1994) go on to note that negotiation is the key to navigating the relationships of power and the interests of the stakeholders in a program.

The participants in the adult learning-based theory of K12 educator professional learning for technology adoption are teachers, administrators, and facilitators. These stakeholders, or participants, interact on an ongoing basis to make up the system states of the theory (discussed in a later section of this chapter). The two views of power offer differing insights for the interpersonal context of the participants in this system. The first view of power, that those who possess it use it to oppress others (Freire, 2000), specifically identifies how some participants in the system might use their power to influence the actions, words and thoughts of others. This could occur in a pejorative way, as in a dictatorial administrator, or in a supportive way, as in second order leadership distributed among teacher-leaders and facilitators. From a more critical perspective one could argue that power gets used to influence the very idea of using technology in education (Robertson, 2003).

The second view of power concerns how power gets used in interpersonal relationships. The participants in the system exist in relationships of power with each other. Sometimes participants unwittingly reinforce systems of power (Foucault, 1980). For example, some might argue that teachers who successfully complete mandated professional development hours on topics deemed not useful are reinforcing the system that requires them to do so (Brookfield, 2001; Foucault, 1980). One way to think about the two views of power would be for all of the participants in the system to become aware of how power gets used

and plan their actions to negotiate the use of power in an interpersonal way to support an environment conducive for learning. Following are discussions about the indicators of the unit, leadership, organizational culture, and collaboration.

The participants in the system (facilitators, administrators, and teachers) will be explained in greater detail in a later section of this chapter on system states. In this system facilitators and administrators share leadership in K12 educator professional learning to support technology adoption. The terms facilitators and administrators indicate more about the role played than the specific title of the person in that role. For example, the term administrators indicates one or more people acting for the district administration and managing administrative tasks. The term facilitators indicates one or more people interacting with teachers on professional learning. The interplay of these roles is key to the indicators of this unit and to the state of the system.

### Indicators of the Unit

The first indicator of the unit interpersonal context is leadership. Teachers who share the vision for education technology of their administrators and facilitators engage more fully in professional learning, therefore a key role for administrators and facilitators is to create a shared vision for the use of technology (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012). Beyond that, principals' technology leadership proficiency positively correlates with teachers' abilities to use technology to support teaching and learning and with teacher access to professional development (Fisher & Waller, 2013; Page-Jones, 2010). Principals recognize the need for their own professional development with technology, and increasingly use technology in accomplishing daily work (Brockmeier, Sermon & Hope, 2005).

Facilitators and administrators must provide teachers with learning opportunities that get at mindset (Ertmer & Ottenbreit-Leftwich, 2010; Hoekstra & Korthagen, 2011). "Specifically, we must focus our change efforts on helping teachers understand how student-centered practices, supported by technology, affect student learning outcomes. This, then, has the potential to affect substantial changes in knowledge, beliefs, and culture" (Ertmer & Ottenbreit-Leftwich, 2010, p. 277). The roles for leaders in a technology one-to-one include motivator and change agent. Leaders must promote flexibility and collaboration, and account for the complexities of the personal, and the social, political and economic contexts (Davies, 2010; Oliver, Mollette, & Corn, 2012). Leadership at this level requires administrators and facilitators to become aware of how power gets used and lead the efforts to truly negotiate the exercise of power among all participants in the system. Principals see access to technology, instructional use of technology, and professional development in the use of technology as areas of school improvement (Lecklider, Britten, & Clausen, 2009).

The second indicator, school or organizational culture, affects the way that teachers engage in professional learning for technology adoption. Contextual factors include learning situated in classroom teaching challenges, how teachers are managed, and the culture of the school toward teacher learning (Van Eekelen, Vermunt, & Boshuizen, 2006). Although forward thinking teachers persist in their efforts to implement technology and 21st century skills in student-centered environments, strong school cultures that oppose new ways of thinking about teaching and learning sometimes overpower individual efforts (Ertmer & Ottenbreit-Leftwich, 2010). School cultures that support the use of technology and teaching of 21st century skills affect the way teachers think about it in a positive way. Negative school

cultures affect teachers in a negative way. The key is that the context of the culture must promote within teachers the idea that personal agency matters, that they can take action to learn, and that they can be successful (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012).

Opfer and Pedder (2011) examined literature across a broad spectrum, including "teacher professional development, teaching and learning, teacher change, and organizational learning" (p. 376) that resulted in a description of teacher learning that is "overwhelmingly multicausal, multidimensional, and multicorrelational" (p. 394). To understand teacher learning one must consider the interplay of the subsystems of the school, the teacher and the learning activity (Opfer & Pedder, 2011). The context, beliefs and practices of the teacher both influence and are influenced by that of the school and the learning activity. The authors conclude:

> To understand and explain why and how teachers learn, we must consider how a teacher's individual learning orientation system interacts with the school's learning orientation system and how both of these systems together affect the activities (and features of activities) in which teachers participate and then are reciprocally affected by the changes that occur from participation in these activities. (Opfer & Pedder, 2011, pp. 393-394)

School level beliefs about learning influence both individual and school behaviors by creating norms for how teachers take action on an ongoing basis. Likewise, schools function in ways similar to individuals around generally supporting learning and learning practices, developing an organizational capacity for learning, and using dissonance as a catalyst to change when practices and beliefs come into conflict (Opfer & Pedder, 2011). This

description of the complex interactions between the teacher, the school, and the learning activity align closely with the participants in this system where the administrators are equal to the school and the facilitators are equal to the learning activity in the way that interact with teachers.

Positive or enabling school cultures promote teacher collaboration, the third indicator of the unit. In a randomized study of 545 teachers at 75 schools in a Midwestern state of the United States, Adams and Forsyth (2006) studied collective teacher efficacy – a construct that measures the collective teachers' beliefs about the ability of the faculty to influence student learning. While past individual mastery performance explains differences in individual efficacy, the authors found that enabling school structures accounted for a significant variability in collective teacher efficacy (Adams & Forsyth, 2006). Caskey and Carpenter (2012) used a situated learning theoretical model to identify three methods of teacher collaboration to support learning: common planning time, critical friends, and professional learning communities. These strategies engage teachers in learning with colleagues about topics that directly address ongoing needs situated in day-to-day practice (Caskey & Carpenter, 2012). Other strategies that promote collaboration include modeling and classroom visits, (Ertmer & Ottenbreit-Leftwich, 2010). Factors critical to implementing collaborative learning environments include supportive leadership, a shared vision of inquiry, trust, and transparency regarding teaching practice (Caskey & Carpenter, 2012).

Engaging in collaborative peer-planning and classroom-based inquiry proved to be effective in teachers explicitly learning how to take responsibility for their own learning and promote learning autonomy for students (James & McCormick 2009). Teacher values, beliefs

and practices may vary, impacting the overall school culture. In a study of how teacher learning impacts student learning, James and McCormick conclude:

> The key challenge for leadership is, therefore, to create the space and climate for school staff to reflect on and share aspects of their practice. This includes encouraging and stimulating dialogue and risk taking. In this way, innovations can be tested, embedded and sustained. Without it, they remain surface changes that decay and disappear when the next initiative comes along. (James & McCormick, 2009, p. 982)

The interpersonal context unit necessarily accounts for the interactions of the participants in the system, teachers, facilitators, and administrators, but particularly in how those interactions affect professional learning to support technology adoption. The indicators of leadership, organizational culture, and collaboration account for interpersonal interactions across the unit.

### Theory-Building Research Logic

This unit, interpersonal context, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). This is a collective unit, consisting of the combination of all the interpersonal contexts of the participants in the system. It is a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Unit Seven: Readiness to Learn

The key indicators for the readiness to learn unit are (a) increasingly self-directed as a learner, (b) the importance of life experiences, (c) knowing why the learning is important, (d) engaging in authentic learning, (e) intrinsic motivation to learn, and (f) intellectual readiness to learn. These are the assumptions of andragogy as outlined by Knowles (1973, 1980b; Knowles, et al., 1998). Chapter Two provides an overview of andragogy. The assumptions will be examined as indicators of the unit followed by a discussion of the theory-building research logic for this unit.

### Indicators of the Unit

The seventh unit in the adult learning-based theory of K12 educator professional learning for technology adoption is readiness to learn. Knowles (1973) listed readiness to learn as one of the core assumption or principles of andragogy. As discussed in Chapter Two, Knowles (1970) defined andragogy as "the art and science of helping adults learn (p. 38). His assumptions of andragogy, then, describe principles of learning in which adults may differ from children (Knowles, 1973). Over time Knowles clarified his beliefs about adult learners and child learners, describing andragogy as an alternative to pedagogy and positioning pedagogy and andragogy as a continuum that moves from less mature to more mature learners instead of from children to adults (Knowles, 1980; Knowles, et al., 1998).

Using andragogy as a framework in the adult learning-based theory of K12 educator professional learning for technology adoption may help participants in K12 educator learning situations understand how to be more intentional about the process (Donavant, 2009). In addition to readiness to learn, Knowles listed five other assumptions of andragogy: (a) adult

learners become increasingly self-directed, (b) learners' life experiences influence their learning, (c) learning should solve a problem or support a task, (d) learners should be intrinsically motivated, and (e) learners want to know why the learning is important (Knowles, et al., 2005). Applied as a framework, all of the assumptions of andragogy engage the adult (mature) learner in a more intentional way.

For the purposes of this theory-building research to create the adult learning-based theory of K12 educator professional learning for technology adoption, readiness to learn will encapsulate all of Knowles's assumptions of andragogy. The next section distinguishes readiness to learn as defined by Knowles from readiness to learn as a unit of the adult learning-based theory of K12 educator professional learning for technology adoption.

Knowles (1973) explained his reasoning about readiness to learn as an assumption of andragogy, "… as an individual matures, his readiness to learn is decreasingly the product of his biological development and academic pressure and is increasingly the product of the developmental tasks required for the performance of his evolving social roles" (p. 46). Knowles went on to describe the pedagogical assumption that children learn what they developmentally "ought" to learn and the andragogical assumption that adults learn what they "need" to learn to support their life-roles (p. 47).

This definition of readiness to learn as an andragogical assumption unique from the five other assumptions also serves to define how all of the assumptions may be joined together. The difference between ought to learn (pedagogy) and need to learn (andragogy) fits all of the assumptions of andragogy (Knowles, 1973; Knowles et al., 2005). Learners become self-directed when they express a need to learn something. Needing to learn

something indicates that the learning has a purpose or solves a problem and that the learner needing to learn knows why the learning is important. Being self-directed and purposeful in a need to learn implies that the learning both leverages and improves the life experiences of the learner. Finally, self-directed learners who express a need to learn something that leverages their experience and addresses a problem are already intrinsically motivated to learn.

Knowles (1973) emphasized the learner's need to know as an indicator that the learner was ready to learn. While this is certainly sufficient for Knowles's explanation of only one andragogical assumption the same approach may be used to encapsulate all of the assumptions of andragogy. The broader definition of need to learn discussed here expands the term readiness to learn to include all of the assumptions of andragogy. For the purposes of this theory-building research Readiness to Learn will be a unit of the theory and indicate a measurement of the learner's capability in the assumptions of andragogy.

Another way to look at the readiness to learn unit would be through the will to learn, "a psychological state in which the learner has a desire to learn" (Van Eekelen, et al., p. 410). Absent the will to learn, sharing classroom-teaching experiences may be taken for granted as a confirmation of status quo as opposed to an opportunity to see something new. A will to learn leads teachers to seek out new strategies, engaging in the process of teacher "tinkering," where a good idea gets tested and modified to become more effective (Hargreaves, 1999). Three manifestations of the will to learn identified in the study include: "(a) those who do not see the need to learn, (b) those who wonder how to learn, and (c) those who are eager to learn" (Van Eekelen, et al., p. 408).

Using the distinction between “ought to learn” and “need to learn” as a way to get at the essence of andragogy provides a powerful starting point to combine the assumptions into one unit. Dubin (1978) allows for an indicator of a unit to become the shortened or familiar name of a unit. Starting from the need to learn, combining the six assumptions of andragogy together provides a complete picture of the overall readiness of the participants in the system to engage in professional learning. The last unit in the adult learning-based theory of K12 educator professional learning for technology adoption is transformative learning. Because the unit readiness to learn has a positive influence on the unit transformative learning one might also think of the unit readiness to learn as readiness to engage in transformative learning.

### Theory-Building Research Logic

With regard to Dubin’s (1978) system of classifying and describing units this unit is variable because it exists in varying amounts, real because it is measurable, sophisticated because it is defined and collective because it describes the context of a group of educators. This unit may also be classified as an enumerative unit meaning that it is present in all participants in the model.

## Unit Eight: Transformative Learning

The key indicators for the unit transformative learning are (a) critical self-reflection; (b) recognize frames of reference and imagine alternatives; and (c) dialoguing with others to test new ideas and resolve contested beliefs (Mezirow, 1997). This is a three-step summary of Mezirow’s (1997, 2000) transformative learning model examined in more detail in

Chapter Two. The steps of the model will be examined as indicators of the unit followed by a discussion of the theory-building research logic for this unit.

## Indicators of the Unit

The eighth unit in the adult learning-based theory of K12 educator professional learning for technology adoption is transformative learning among participants. Mezirow's theory provides a pathway for helping K12 educators experience transformational learning in the area of technology adoption. The discussion in Chapter Two provides a simple way to think about transformative learning. If adults encounter something unexpected, something that does not fit with their current beliefs, ways of knowing, and ways of doing, then they must choose to either ignore the unexpected or to question their belief system and find ways to accommodate the unexpected (Cranton, 2006; Mezirow, 1997). Mezirow called the unexpected a disorienting dilemma and the process of accommodating a disorienting dilemma into one's frame of reference he called transformative learning (Mezirow, 2000).

Mezirow identified three key elements of transformative learning: (1) become critical in assessing assumptions of others and of one's own beliefs, values, judgments and feelings; (2) recognize frames of reference and imagine alternatives; and (3) work with others to assess reasons, pose and solve problems, and arrive at a tentative best judgment regarding contested beliefs (Mezirow, 1997). Mezirow adds that transformative learning is core to the adult learning process.

Transformative learning is not an add-on. It is the essence of adult education. With this premise in mind, it becomes clear that the goal of adult education is implied by the nature of adult learning and communication: to help the individual become a more

autonomous thinker by learning to negotiate his or her own values, meanings, and purposes rather than to uncritically act on those of others. (Mezirow, 1997, p. 11)

Mezirow asserts that experiencing transformative learning requires a certain readiness acquired in the process of becoming an adult. Explanations that worked in childhood may not suffice in adulthood because adults enjoy a deeper understanding of the historical, cultural, and biographical context that affect their beliefs, values, and feelings. This depth of understanding opens the door for an adult to become "… critically aware of one's own tacit assumptions and expectations and those of others and [to assess] their relevance for making an interpretation" (2000, p. 4). Teacher beliefs are rooted in how they were taught and these preconceptions are difficult to change. Teachers may assimilate new beliefs into their beliefs and vocabulary without changing their real beliefs (Hoekstra & Korthagen, 2011). Transformative learning provides a pathway for teachers to examine those beliefs and consider new ideas.

In a study of 175 K12 teachers over a 36-month period, King (2002) devised a method to measure transformative learning as related to teachers engaged in professional development in support of technology adoption for their classrooms. Using the transformative learning theoretical concepts of disorienting dilemma, critiquing one's beliefs, recognizing frames of reference, and dialoguing with others to determine solutions fits well with the experiences of teachers trying to embrace new technologies, new skill sets, and new strategies for classroom instruction and management (King, 2002).

King's study used ''The Learning Activities Survey-Technology Form'' (King, 1998, 2002) and a variety of qualitative methods including journals, reflective essays and

interviews to determine whether educators involved in educational technology professional development experienced transformational learning. This methodology provided a way to measure the transformational impact on teachers as a result of the professional development to support technology adoption. Teachers experienced a shift in two key areas, their perspective of role of the teacher and their perspective on their world-view of education (King, 2002). Teachers learned the value of reflecting on their own practices, broadened their sense of teaching and learning strategies, began to take control of extending their learning to new areas, and shifted towards more student-centered practices (King 2002).

Using transformative learning as a unit in the adult learning-based theory of K12 educator professional learning for technology adoption brings an important adult learning theory, transformative learning, that has been demonstrated to impact K12 professional development for technology adoption (King, 2002).

## Theory-Building Research Logic

This unit, transformative learning, is real and sophisticated because it can be defined by consistent, empirical indicators (Dubin, 1978). This is a collective unit, consisting of the combined effects of transformative learning on the participants in the system of K12 educator professional learning for technology adoption. It is a variable unit that exists in degrees and may be classified as an enumerative unit meaning that it is present in/impacts all participants in the model (Dubin, 1978).

## Summary of Units

This section provided an overview to step one of Dubin's (1978) theory-building research model, Units, and identified the eight units for the adult learning-based theory of K12 educator professional learning for technology adoption. Each of the Units was described through its indicators and was logically validated with Dubin's (1978) model. The eight units for the theory are:

**Unit One**: Technology Implementation in K12 Education

**Unit Two**: Personal Context

**Unit Three**: Physical Environment

**Unit Four**: Digital Environment

**Unit Five**: Policy Environment

**Unit Six**: Interpersonal Context

**Unit Seven**: Readiness to Learn

**Unit Eight**: Transformative Learning

## Laws of Interaction of the Theory

### Dubin's Explanation of Laws of Interaction

Laws of interaction describe the relationship between units (Dubin, 1978). Units may be measured; laws of interaction may not be measured. Laws of interaction establish a relationship but not causality. The three types of laws of interaction are categoric, sequential, and determinant. Categoric interactions associate values in one unit with values in another unit. Sequential interactions use a time dimension to order the relationships between units.

Determinant interactions associate determinate values in one unit with determinate values in another unit (Dubin 1978).

The efficiency of a law of interaction may be designated with four general labels, from lowest level of efficiency to highest: presence-absence, directionality, covariation, rate of change. Presence-absence indicates that given the positive or negative presence of a unit A, there will be a positive or negative presence of another unit B. Directionality indicates that as unit A increases, unit B will increase (Dubin, 1978). Dubin (1978) notes that this level of efficiency in laws of interaction is frequently used in the social sciences. Covariation indicates that the statement of the law of interaction accounts for the changes in the directionality between the units. Rate of change, the highest level of efficiency, indicates the rate of change of the values of one unit and the associated rate of change of the values of another unit (Dubin, 1978).

Dubin (1978) next discusses the relationship between the types of laws of interaction and the levels of efficiency. A categoric law will always be at the lowest level of efficiency, presence-absence. Categoric laws of interaction are commonly used in social sciences as a way of developing understanding of a theory but fall short in using the theory for prediction. Determinant laws of interaction will always be at the second or higher level of efficiency because they define directionality, covariation, and rate of change. Determinant laws of interaction will always be more efficient than categoric laws of interaction. Sequential laws of interaction may be at any level of efficiency. Dubin reminds his readers that the temptation to assign causality to sequential laws of interaction should be resisted and that sequential laws should be used, instead, to focus on the unique property of time.

A theory must have at least one law of interaction relating two units. The maximum number of laws in a theory must equal the number needed to relate the units two at a time to all of the other units. Using more efficient laws, the parsimony of laws, allows the maximum number to be reduced. An example of this would be that for units A and B, categoric laws of interaction would require four laws to state the relationship between the units: (a) A and B, (b) A and Not B, (c) Not A and B, and (d) Not A and Not B. A more efficient determinant law of interaction for units A and B would require only one law of interaction to state the relationship, such as, An increase of 10% in A causes an increase of 25% in B (Dubin, 1978). Figure 27 shows the interactions between the units as described in the following section.

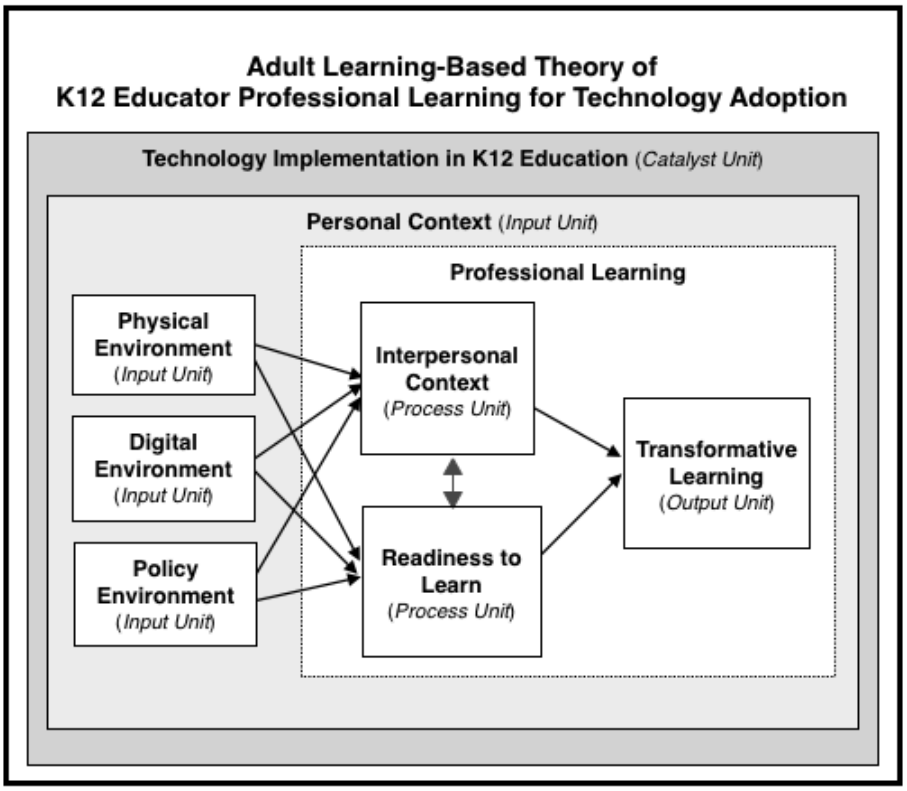


Figure 27. Units and laws of interaction in the adult learning-based theory of K12 educator professional learning for technology adoption.

## Laws of Interaction

### Law One

Technology implementation in K12 education is a catalyst unit that must be present to activate the laws of interaction between all other units.

As discussed previously technology implementation in K12 education is a catalyst unit that by its presence activates the laws of interaction between the other units in the model. Without the technology implementation, in some form or another, system participants have no reason to engage in professional learning to support technology adoption and thus the

system does not retain its integrity. Future studies may identify different catalyst units that interact with the system in a similar way and activate the laws of interaction between the other units of the model.

### Theory-Building Research Logic

Law 1 is a categoric law, indicated by its role as a catalyst unit. By its existence, the unit activates the laws of interaction between other units. As a categoric law at the lowest level of efficiency, it either exists or it does not, and its existence associates the values of one unit with another (Dubin, 1978).

### Law Two

Personal context will influence all other units and the interactions between them.

The key indicators for personal context are perceived ease of use of technology, perceived usefulness, experience, and voluntariness, focus on personal beliefs about the use of technology (Venkatesh and Bala, 2008). Two of the indicators, perceived ease of use of technology and perceived usefulness are key determinants in the Technology Acceptance Model (TAM), and provide a way to understand how individual beliefs about technology in influence behavioral intention and actual use of technology (Venkatesh, 2000, Venkatesh & Davis, 1996). The other two indicators, experience and voluntariness are moderators of the determinants and provide a way to account for personal demographic differences and issues around intrinsic motivation (Venkatesh, 2000; Venkatesh and Bala, 2008). The teachers, administrators, and facilitators in the system hold unique beliefs about the use of technology that influence all of the units in the model. Understanding these various personal contexts

and how they impact the overall model matter from both an individual and a systems perspective.

### Theory-Building Research Logic

Law 2 is a determinant law that allows it to associate determinate values in one unit with determinate values in another unit. It is at the second level of efficiency because it indicates directionality between personal context and the other units of the theory that an increase in the value of personal context will lead to an increase in value of the other units in the model.

### Law Three

The units physical, digital, and policy environment influence interpersonal context and readiness to learn.

Physical environment refers to the spaces and ambience where professional learning occurs and the equipment and materials needed in support (Caffarella, 2002; Knowles, 1973, 1980a). Spaces and ambience include many aspects of human comfort, including the size and temperature of the room, the type and arrangement of furniture, and access to facilities. Providing appropriate equipment and materials helps participants feel professionally respected, promotes interactivity among participants, and improves the quality of the learning (Cafarella, 2002; Hartwig, 2000; Knowles, 1973).

The digital environment refers to access to equipment, always-on connectivity to the Internet and content, support and sustainability, and virtual spaces (Cercone, 2008; Oliver, et al., 2012. Teachers and administrators often cite lack of access to reliable equipment and

connectivity as among the barriers to implementing technology (Cottle, 2010; Kopcha, 2012); Lu & Overbaugh, 2009). As digital environments become more reliable more educators participate in professional learning in virtual spaces, making the design of these spaces for teaching and learning an important strategy (Cercone, 2008).

The policy environment refers to standards, policies, and practices that impact educator professional development. Standards and policies implemented in an overbearing or restrictive way become a barrier to technology adoption and negatively affect teacher self-efficacy (Cottle, 2010; James & McCormick, 2009; Lu & Overbaugh 2009). School and district practices, such as predetermined professional development that does not address authentic problems in teaching and learning or master schedules that do not allow for educators to meet together for planning inhibit motivation for and engagement in meaningful professional learning (James & McCormick, 2009; Kopcha, 2012).

The units of physical, digital, and policy environment all influence the interpersonal context of the system, that is, how people interact. The indicators for interpersonal context include leadership, organizational culture, and collaboration (Ertmer & Ottenbreit-Leftwich, 2010; Knowles, 1973, 1980a; Kopcha, 2012). Administrators and facilitators have more opportunities than teachers to impact the units on physical, digital, and policy environment (Caskey & Carpenter, 2012).

The units of physical, digital, and policy environment all influence the readiness to learn of the participants in the system by supporting self-directed, authentic, and experienced-based learning in ways that honor teachers as learners while helping participants create a shared vision of why the learning is important. While the environment units

influence the units personal context and readiness to learn they are, taken as individual units, input units that provide content to other units. Higher values in each of the three environment units results in higher values in interpersonal context and readiness to learn.

The combined effect of higher values in the physical, digital and policy environments influences interpersonal context and readiness to learn to create what Adams and Forsyth (2006) called enabling school cultures that improve collective teacher efficacy.

### Theory-Building Research Logic

Law 3 is a determinant law that allows it to associate determinate values in one unit with determinate values in another unit. It is at the second level of efficiency because it indicates directionality between the physical, digital, and policy environment units and interpersonal context, and between the physical, digital, and policy environment units and readiness to learn (Dubin, 1978). An increase in the value of physical environment, digital environment, or policy environment will lead to an increase in the value of interpersonal context and readiness to learn.

### Law Four

Interpersonal context and readiness to learn have a two-way relationship: (a) Interpersonal context influences readiness to learn, and (b) readiness to learn influences interpersonal context.

The indicators for interpersonal context include leadership, organizational culture, and collaboration, all couched in the context of how power gets exercised across the system. Participants in the system must first become aware of the use of power in interpersonal

relationships (Brookfield, 2001), then begin a process of negotiation around the use of power in the system to promote professional learning to support technology adoption (Cervero & Wilson, 1994; Davies, 2010; Oliver, et al., 2012). Good leadership in technology implementation includes promoting an organizational culture that supports ongoing collaboration among system participants (Ertmer & Ottenbreit-Leftwich, 2010; Kopcha, 2012).

The readiness to learn unit mirrors the assumptions of andragogy (Knowles, 1973, 1980b; Knowles, et al., 1998) that adult learners (or, educators) are increasingly self-directed as learners, activate their life experiences into their learning, seek to understand why learning is important, want to engage in authentic learning, are intrinsically motivated to learn and are intellectually prepared to learn (Knowles, 1973, 1980b; Knowles, et al., 1998). These characteristics of andragogy emerge out of a need to learn among adults (educators) and together make up an overall value of readiness to participate in professional learning for technology adoption (Hurt, 2007; Knowles, 1973, 1980b; Potter & Rockinson-Szapkiw, 2012). Knowles added to this list the need to be collaborative in learning (Knowles, 1980b).

This connection to the unit interpersonal context brings in the indicators of leadership, organizational culture and collaboration. The process of andragogy entails dialogue between the learners and the facilitators so that each of the andragogical assumptions gets intentionally pulled and teased to help system participants identify learning needs and strategies. An andragogical effect emerges out of the process that maximizes the learning and facilitating capabilities of the participants (Knowles, 1973, 1980a, 1980b). It is at this level of the unit that professional learning ensues and that makes the units

interpersonal context and readiness to learn process units. That is, they exist and interact in the process of learning.

### Theory-Building Research Logic

Law 4 is a determinant law that allows it to associate determinate values in one unit with determinate values in another unit. It is at the second level of efficiency because it indicates directionality between interpersonal context and readiness to learn (Dubin, 1978). An increase in the value of interpersonal context will lead to an increase in the value of readiness to learn. An increase in the value of readiness to learn will lead to an increase in interpersonal context.

### Law Five

Interpersonal context and readiness to learn influence transformative learning in professional learning for technology adoption.

As discussed in Chapter Two the key indicators for the unit transformative learning are (a) critical self-reflection; (b) recognizing frames of reference and imagine alternatives; and (c) dialoguing with others to test new ideas and resolve contested beliefs (Mezirow, 1997). Experiencing transformative learning requires an ability to engage in critical self-reflection that resolves new ideas (or, disorienting dilemmas) and helps reframe one's frame of reference (Mezirow, 1997, 2000; Cranton, 2002). Readiness to learn, driven by a need to learn and the assumptions of andragogy, provides an excellent platform from which to engage in critical self-reflection, recognize frames of reference, and imagine alternatives. Interpersonal context, with the indicators of leadership, school culture and collaboration,

provides a framework from which to imagine alternatives and dialogue with others to test new ideas and resolve contested beliefs. Lower values in the readiness to learn and interpersonal context units will result in lower values in the transformative learning unit.

### Theory-Building Research Logic

Law 5 is a determinant law that allows it to associate determinate values in one unit with determinate values in another unit. It is at the second level of efficiency because it indicates directionality between interpersonal context and transformative learning, and between readiness to learn and transformative learning (Dubin, 1978). An increase in the value of interpersonal context will lead to an increase in the value of transformative learning. An increase in the value of readiness to learn will lead to an increase in the value of transformative learning.

### Summary of Laws of Interaction

This section provided an overview of step two of Dubin's theory-building research model, Laws of Interaction, and set forth the five laws of interaction for the adult learning-based theory of K12 educator professional learning for technology adoption. Each of the laws was logically validated with Dubin's (1978) model. The five laws of interaction for the theory are:

**Law One**: Technology implementation in K12 education is a catalyst unit that must be present to activate the laws of interaction between all other units.

**Law Two**: Personal context will influence all other units and the interactions between them.

**Law Three**: The units physical, digital, and policy environment influence interpersonal context and readiness to learn.

**Law Four:** Interpersonal context and readiness to learn have a two-way relationship: (a) Interpersonal context influences readiness to learn, and (b) readiness to learn influences interpersonal context.

**Law Five**: Interpersonal context and readiness to learn influence transformative learning in learning professional learning for technology adoption.

The next section examines the third step of Dubin's (1978) model, boundaries of the theory, and explains the boundaries of the adult learning-based theory of K12 educator professional learning for technology adoption.

## Boundaries of the Theory

### Dubin's Explanation of the Boundaries of a Theory

Knowing the limiting values of the units of a theory provides a set of boundaries. Boundaries are determinate, derived from the characteristics of the units of the theory or the characteristics of the laws of interaction between the units. In these cases the limiting values are internal to the model. Limiting values, or boundaries may also be determined by criteria external to the model (Dubin, 1978). The boundaries may serve to enclose a system, or a model, however some systems may remain open with true exchange between the system and its environment. This occurs when laws of interaction properly define exchange across a boundary. Dubin (1978) maintains that open systems may be closed by adding a unit to the

system then defining its laws of interaction with other units in such a way that the boundaries are known and that no boundaries are crossed by other laws of interaction.

Boundaries must apply equally to both units and their laws of interaction. The researcher has two options for determining boundary criteria: (1) use a logical model, a syllogism or truth test, to understand the boundaries of the units and the laws of interaction between the units, and (2) use an empirical test to determine that the boundary criteria apply to the units and laws (Dubin, 1978).

Boundary criteria may be classified as interior criteria, those derived from the characteristics of the laws and units in the model, and as external criteria, those derived from factors outside the model. Interior criteria typically get formulated using the logic or empirical tests. Exterior criteria may be formulated after the initial testing of the model reveals a law of interaction that crosses the other boundaries of the model, thus making the model an open system. The remedy for this discovery during testing, referred to by Dubin as the often-used intervening variable, would require adding a unit to the model and redefining the model's laws of interactions to either meet the existing boundary criteria or add additional criteria. Another use of external boundary criteria might be to add boundaries to the model that do not actively affect the way the model works. Thus some exterior boundary criteria actively affect the model (the intervening variable) and others just passively define boundaries while otherwise not affecting the model (Dubin, 1978).

Boundaries impact the size of the domain of a model or theory with an inverse relationship. Adding boundaries to a model decreases the size of the domain (Dubin, 1978). Dubin (1978) provides a definition of what he means by the domain of a model: "… the

territory over which we can make truth statements about the model and, therefore, about the values of the units composing the model" (p. 134-135). Adding a boundary criterion to a model results in removing a unit from the model or constricting the laws of interaction between the units of the model and makes the model more homogeneous. While moving toward more purity in the model may be desirable in terms of conducting research Dubin (1978) cautions that the researcher still wants to have the ability to generalize about the model and that the size of the domain is the area around which the model may be generalized.

For example, andragogy frequently gets defined as a model with assumptions about the unique ways in which adults learn (Knowles, 1973; Knowles, et al., 2005). In andragogy adults and learning would be units and the assumptions of andragogy would define the laws of interaction between the two units. The boundary criteria would include defining what we mean by adult and what we mean by learning. Being an adult learner might be defined by age and mental capacity. Over time (and as a result of research) Knowles broadened the boundary criteria for the meaning of adult to remove the qualification of age as long as the laws of interaction (assumptions) held true, thus allowing andragogy to work more as a model that supports learning in general (Knowles, 1980b; Knowles, et al., 1998).

In addition to limiting the boundary criteria as a way of broadening the domain of a model, researchers frequently combine narrow models together to create a more general model (Dubin, 1978). The narrow models would all satisfy restricting boundary criteria but where the narrow models are isomorphic a new, more generalizable model would emerge that satisfies less restrictive boundary criteria. For example, combining elements of

andragogy with elements of transformative learning may yield a new model that could support K12 educator professional learning for technology adoption.

Testing the boundary criteria of a model by logical or empirical means remains an essential part of the theory-building research process. The results of testing should reveal whether the boundaries of the model need to be shifted or if the units and laws of interaction need to be altered (Dubin, 1978).

## Defining the Boundaries

The adult learning-based theory of K12 educator professional learning for technology adoption uses the following boundaries: (a) the participants are K12 teachers, administrators, and facilitators and (b) the participants are engaged in formal learning about the use of technology to support teaching and learning in a technology implementation. In additional studies the model may extend beyond these boundaries to informal learning and topics beyond the use of technology to support teaching and learning, but this study focuses on these parameters.

Regarding the boundary of the participants in this study K12 teachers means college-educated teachers employed to teach students in a K12 educational setting. Using this definition allows the model to include non-certified teachers and beginning teachers with no formal teaching experience. It does not allow for student-teachers as they are not employed as teachers.

Excluding student-teachers also addresses the adult learning aspects of the model. In a meta-study of the research on andragogy, Rachal (2002) identifies adult status as one of seven criteria for creating an empirically researchable model for studying the impact of

andragogy. Indeed, Rachel (2202) identifies the use of undergraduate college students in adult learning-based studies as a weakness, asserting that those students have not necessarily reached adult status. Rachal defines adult learners as "learners who have assumed the social and culturally-defined roles characteristic of adulthood and who perceive themselves to be adults, or, if those qualities are not ascertainable, learners who have achieved an age, such as 25, which would be regarded as adult irrelevant of social circumstances" (p. 220). This definition aligns with definitions discussed by others suggesting that an adult must be either the head of a household or married (Merriam, et al., 2007).

To continue defining the boundaries of the adult learning-based theory of K12 educator professional learning for technology adoption, the term K12 administrators refers to those employed as administrators in in a K12 institution. The term K12 facilitators refers to those employed to facilitate professional learning in a K12 institution working with K12 teachers and administrators. K12 facilitators may be employed directly by the district of the participating teachers and administrators or employed on a contract basis as a consultant. K12 administrators may also be facilitators of learning in their K12 institution working with K12 teachers and administrators (e.g., the principal as an instructional leader facilitating learning with the school faculty).

### Summary of Boundaries

This section provided an overview to step three of Dubin's (1978) theory-building research model, Boundaries, and set forth boundaries for the adult learning-based theory of K12 educator professional learning for technology adoption. Each of the boundaries was described through its indicators and was logically validated with Dubin's (1978) model. The

boundaries of the theory are (a) the participants are K12 teachers, administrators, and facilitators and (b) the participants are engaged in formal learning about the use of technology to support teaching and learning in a K12 education technology implementation. The next section defines the system states of a model in the theory-building research process.

## System States of the Theory

### Dubin's explanation of System States

Using units and the laws of interaction between the units, theorists may describe or predict the values of the units within a set of defined boundaries (Dubin, 1978). Dubin (1978) adds one more building block, system states, to the theory-building research process to account for the fact that not all points within a given set boundary criteria are the same. The following section defines system states, distinguishing them from the outcomes of units, and generally providing guidance on how system states work within Dubin's theory-building research model.

Dubin (1978) explains the three criteria of a state of system: "(1) all units of the system have characteristic value, (2) the characteristic values of all units are determinant, and (3) the constellation of unit values persists through time" (p. 144). If any of these features do not exist, then the system is in transition from one state to another and cannot be defined as a system state. The first criterion, inclusiveness, requires that all of the units in a system have values. The second criterion, determinant values, requires that the units of a system state must be measureable and unique for the state of the system (Dubin, 1978). Dubin (1978) clarifies what he means by measurable: "The values of all units of the model may be

measured, at least in principle, by instruments that give real values, at least within the particular state of the system" (p. 147). The third criterion, persistence through time, provides flexibility over how much time, typically as short as milliseconds for chemical and physical systems and much longer for social systems (hours, days, months, etc.). The state life is the length of time the state persists and is relevant to the laws of interaction between the units of the system (Dubin, 1978). System states may recur and the ability to sequence system states and make predictions about the recurrence provides what Dubin (1978) calls "genuine analytical significance" (p. 150).

Differences exist between the outcome of a unit and a system state. An outcome is a critical value for a unit that gives the unit a special analytical character distinguishing it from other units but that does not affect all of the units simultaneously (Dubin, 1978). A system state "is defined by the unique combination of values of all units composing a system. This combination gives to the system as a whole a distinctive condition" (Dubin, 1978, p. 146).

System states may serve as analytical features of a theory (Dubin, 1978), providing some insight as to what happens when the theory operates. Dubin identifies four analytical problems that system states may address: (1) what conditions exist when the system state persists, (2) what conditions exist when a system state no longer exists, (3) what patterns exist in the sequencing of system states, and (4) what conditions exist when a system becomes permeable, requiring the addition or subtraction of one or more units (Dubin, 1978). Dubin (1978) observes that describing the observable states of a system brings feedback about the system that may require the system to be modified by introducing new states of the system. He concludes that system states "… serve the purpose of specifying a condition for

the system as a whole. When the system as a whole is the focus of attention, the system states become the features of the system of analytical importance" (p. 157).

## Defining the System States

In the adult learning-based theory of K12 educator professional learning for technology adoption the system states focus on the roles played by the participants, the teachers, the administrators, and the professional learning facilitators, and how those roles impact each other. The next section provides an explanation of the teachers, administrators, and facilitators and how the interactions between the participants exist as unique system states for the theory. Figure 28 models the basic interactions possible between the teachers, administrators, and facilitators participating in professional learning for a K12 education technology implementation. The center section of Figure 28 represents a balance in the engagement of the teachers, administrators, and facilitators in support of K12 educator professional development for technology adoption.

Opfer and Peddler (2011) provide support for this system state in recognizing a similar balance for educator professional learning, asserting that the interconnectedness between the teacher, the school (administrator) and the learning activity (facilitator) "interact and combine in different ways and with varying intensities to influence teacher learning" (p. 376).

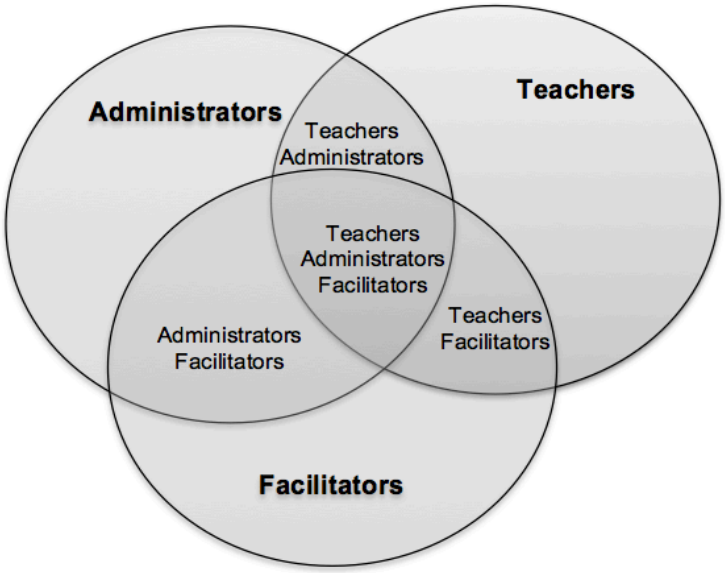


Figure 28. The core system state in the adult learning-based theory of K12 educator professional learning for technology adoption.

Dubin (1978) defines the three criteria of system states as (a) all of the units have characteristic values, (b) the characteristic values of all units are determinant, and (c) those characteristic values of all units persist over time. The participant groups in a system state of the adult learning-based theory of K12 educator professional learning for technology adoption, teachers, administrators, and facilitators, would all experience or exhibit the characteristics of the units in the system. Each group would exhibit personal contextual factors, each would exhibit and experience interpersonal contextual factors, each would experience three aspects of an environment, each would reach a level of readiness to learn, each would experience a technology implementation, and each would have an opportunity to experience transformative learning. These units would exist for the participant groups in

determinant values over a period of time. Thus, the system states formed by the levels of engagement of teachers, administrators, and facilitators in professional learning for a K12 education technology implementation meet the criteria set forth by Dubin (1978). The next section turns to an explanation of each of the participating groups in the system, the teachers, the administrators, and the facilitators.

The theory will always include a system state of teachers, administrators and facilitators, who are connected to K12 educator professional learning to support technology adoption. Typically the number of teachers participating in the implementation will far outnumber the administrators and facilitators. Some teachers in a school may not be included in the model if they are not participating in professional learning to support technology adoption (e.g., implementations that focus on certain content areas and not on others).

Administrators are those who represent the district and/or the state-national regulating agencies and specifically during the time that they are fulfilling that role. For example, principals and curriculum directors in a district may fulfill the role of district administrator on some occasions and professional learning facilitator on other occasions. In that role administrators represent the organization sponsoring the implementation, creating the need for the professional learning, and to some degree ensuring that professional learning activity occurs (Alvarez, 2010). Administrators also represent the district, state, and national organizations that set standards, define teacher and student performance criteria, and in other ways regulate what teachers and students do on a daily basis. Examples include common standards, pacing guides and curriculum materials, district and school master schedules, and standardized assessments (Fisher & Waller, 2013; Lytle, 2010).

Administrators manage these programs, initiatives, procedures and protocols on an ongoing balance each day, week, month and year. Typically, principals represent the administrators in schools and other district-level personnel act as administrators in their interactions with teachers and facilitators (Margolis, 2008). Introducing the catalyst unit, K12 technology implementation to support teaching and learning, requires rebalancing by all participants but particularly by administrators (Margolis, 2008).

The principal may also participate in the professional learning on three levels. On one level the principal may participate as a learner in the professional learning along with teachers. On a second level the principal may administratively manage the structure, timing, and content of professional learning. This may be done with or without other facilitators. On a third level the principal may deliver or lead professional learning experiences with teachers, acting as the facilitator. In all cases the principal would still act as an administrator.

The third group affecting the system states of the adult learning-based theory of K12 educator professional learning for technology adoption consists of professional learning facilitators. This group may include one person or more than one, employed full time by the district or school, or hired as an outside consultant. This group may also include facilitators with responsibilities in other areas outside of the implementation. Facilitators share in common one characteristic, that they support professional learning for the technology implementation by the teachers and administrators of the implementing K12 educational institution. In that sense facilitators differ from administrators because they focus their efforts specifically on supporting the professional learning of the teachers involved in the technology implementation (Brinkerhoff, 2006; Meier, 2005).

As discussed in the section on the unit interpersonal context facilitators must understand the characteristic of power in the planning and execution of professional learning for K12 educators (Cervero & Wilson, 1994). In this role facilitators may form a unique bond with teachers regarding their collective mission to help teachers succeed In the absence of a designated facilitator the principal fills the role, either intentionally or by default (Beavers, 2009; Meier, 2005).

Other cases exist beyond the principal where the facilitator is also an administrator. This may occur if a district or school level professional learning specialist carries responsibilities for implementing other district initiatives, such as implementing new common standards. Interweaving technology implementation and new common standards at the same time would present challenges and offer new possibilities (Wei, et al., 2009).

The way that the participant groups teachers, administrators, and facilitators interact with each other and the unit technology implementation in K12 education defines the system states for the adult learning-based theory of K12 educator professional learning for technology adoption. The three participant groups exert various degrees of influence over the value for the units of the theory both by their number and by the roles that they play in a technology implementation.

Administrators influence the unit values of the policy, digital, and physical environments and the interpersonal context. A system state with low administrator engagement will result in lower values for the interpersonal unit and the three environment units and conversely, a system state with high administrator engagement will result in higher unit values in the same areas. As shown by the unit interactions portrayed in Figure 26

influencing the three areas of environment also causes the administrator to exert additional influence on the interpersonal environment.

A system state with lower facilitators engagement will result in lower interpersonal and personal context unit values and a system state with higher facilitator engagement will result in higher interpersonal and personal unit values. Facilitators support teachers' learning by interacting with them in learning situations and understanding how to leverage the personal contexts in ways conducive to learning.

A system state with lower teacher engagement will result in lower personal and interpersonal unit values and a system state with higher teacher engagement will result in higher personal and interpersonal unit values. This is apparent because of the higher number of teachers engaged than the number of administrators and facilitators.

The system state representations in Figure 28 also serve to define possibilities for how various interactions of participants in the system might impact unit values. For example, the area labeled AF in the system states of Figure 28 represents the interactions between the administrators and the facilitators. The two groups may discuss plans for how to use digital tools to support interactions between teachers during professional learning and for organizing an off-site session at an appealing location with food, thus impacting the units interpersonal contexts, digital environment, and physical environment.

As levels of engagement in the professional learning process by the participants change the system state changes. Figure 29 represents four different system states, each impacted by a change in one or more of the relative interaction and/or size of the circles.

System state a in Figure 29 represents a balance between the engagement of the teachers, administrators, and facilitators that returns maximum unit values. That is, the units on environment, personal context, interpersonal context, readiness to learn, and transformative learning would return maximum values with a balance of engagement of the participants in the system. Variations on the balance between the three, as represented in Figure 29 by system states b, c, and d would return less than maximum value for the units.

System state b in Figure 29 represents a special case where the principal acts as the administrator and the facilitator, thus dividing time and attention between two critical roles. The smaller circles represent the relative amount of time that the principal would have to give (the assumption is that the two smaller circles equal the one larger circle in area and thus in the total amount of time). Although elements of this case exist for others in the system who might be splitting time across multiple roles it is much more acute when the principal is the lead administrator and the lead (or, only) facilitator in support of professional learning to support technology adoption.

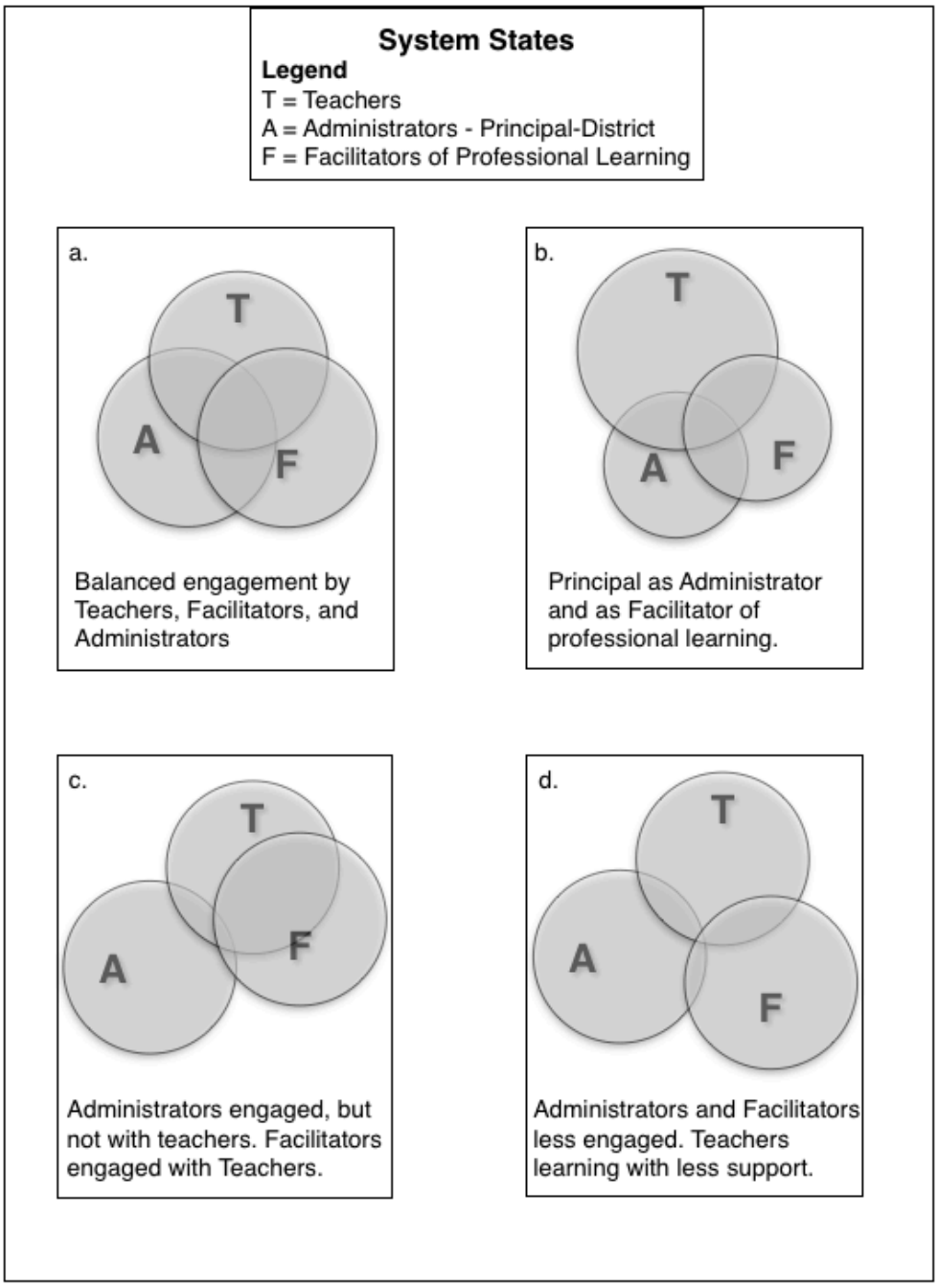


Figure 29. Various system states in the adult learning-based theory of K12 educator professional learning for technology adoption.

System state c in Figure 29 represents less engagement from administrators. The facilitators and teachers remain engaged but a less than optimal level of engagement from the administrators affects the unit values. An example of this would be lower values of the three environment units. Additionally, as previously discussed, lower values in these units would result in lower values in the interpersonal context unit. This state could also be the case if either facilitators or teachers were represented by less engagement providing correspondingly lower unit values in the units most impacted by facilitators and/or teachers.

System state d in figure 29 represents less engagement by two or possibly all three participant groups in the system. As established with system state c, less than optimal engagement by more than one of the three participant groups would result in lower unit values across the system, including the readiness to learn and transformative learning units. Essentially, the technology implementation would be much less likely to result in transformation.

### Summary of System States

This section described the system states of the adult learning-based theory of K12 educator professional learning for technology adoption. The system focuses on the participants in the theory, teachers, administrators, and facilitators, and their level of engagement in the professional learning in support of technology adoption. The participating groups experience or impact each of the units in the theory in characteristic and measurable values over a period of time, thus meeting the criteria for a system state set forth by Dubin (1978). Achieving a perfect balance of the engagement levels of the three participating groups results in maximum values for the units of the theory. Examples of variations from

the perfect balance include less engagement by one, two, or all three of the participant groups and the special case where a principal splits time between the administrator and facilitator roles.

## Chapter Four Summary

This chapter tested ideas from adult learning theory, K12 educator professional development and technology adoption models against Dubin's (1978) theory-building research process resulting in a new theory, the adult learning-based theory of K12 educator professional learning for technology adoption. The process for the chapter went as follows: (1) Explain Dubin's theory-building step, starting with step one; (2) Describe the elements of the proposed theory for the step and provide a research rationale; and (3) Logically validate the elements of the proposed theory using Dubin's theory-building research parameters. The process proceeded through the first four steps that comprise the theory building section of the model, units, laws of interaction, boundaries, and system states. The results are presented in conceptual models, Figures 26-30 that portray the interactions between the units, illustrate system states of the model, and present the theoretical model.

This chapter addressed the first two research questions: 1) Can adult learning theory be used to develop a theory of K12 educator professional learning for technology adoption? and 2) Can adult learning theory be used to conceptualize a theory of K12 educator professional learning for technology adoption? The iterative 3-step process described above provided a way to use Dubin's theory-building research model to develop a theory so Research Question One could be answered in the affirmative. The conceptual models

presented in Chapter Four illustrate the relationships between the components of the theory and, therefore, provide an answer in the affirmative for Research Question Two.

Figure 30 shows the units of the theory and the interactions between them, models a balanced instance of the system state, shows the interactions between participants in the system, teachers, administrators, and facilitators, and defines the boundaries for the system.

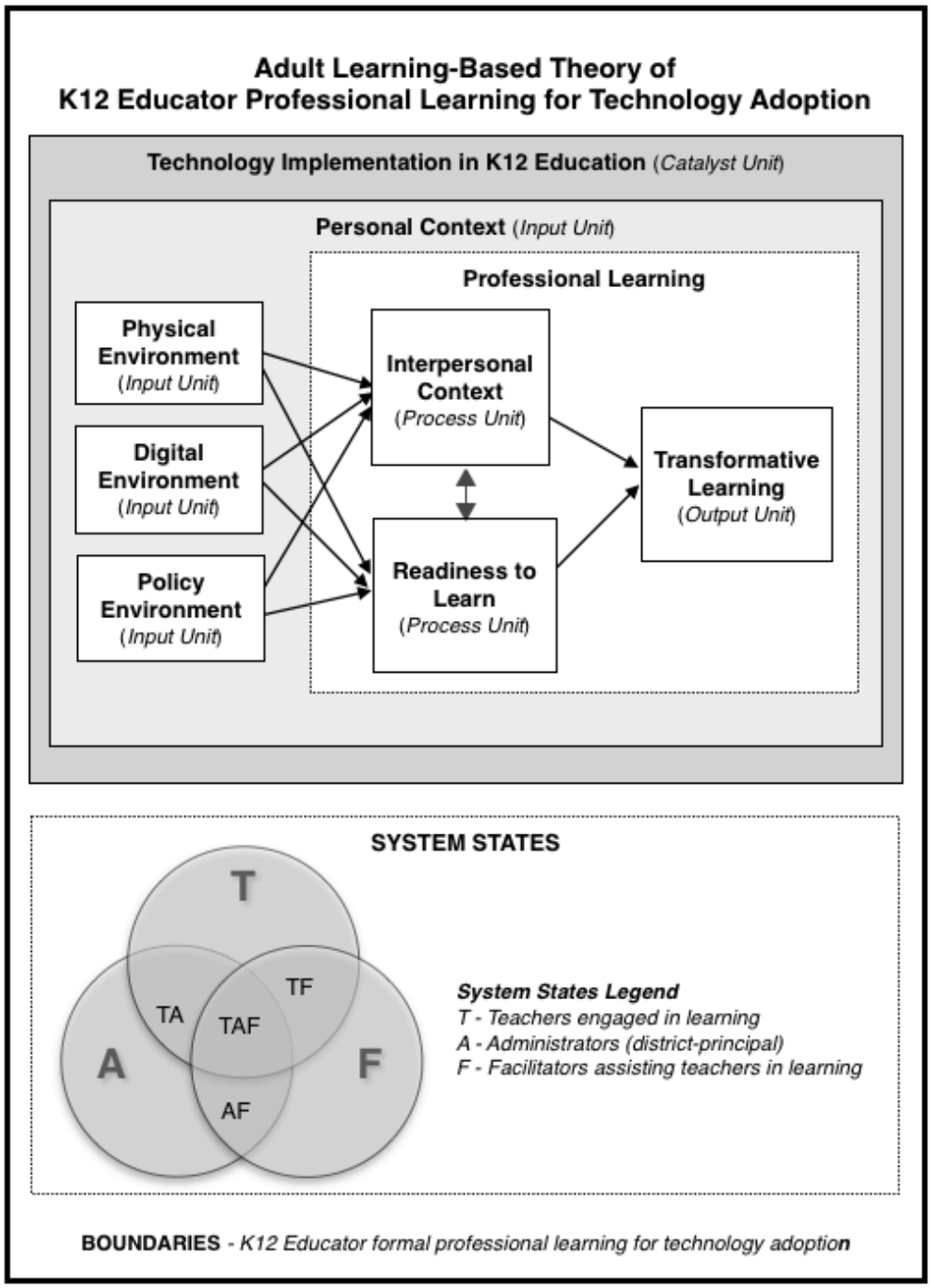


Figure 30. The adult learning-based theory of K12 educator professional learning for technology adoption. Units, laws of interactions, boundaries, and system state representations.

# CHAPTER FIVE

# OPERATIONALIZING AND EVALUATING THE THEORY

Chapter Four applied the first four steps of Dubin's (1978) theory-building research methodology to create the adult learning-based theory of K12 educator professional learning for technology adoption. Chapter Five begins with an examination of the next four steps in the Dubin (1978) theory-building research model that will operationalize the theory. Following a discussion about a proposed research design, the theory will be evaluated using Patterson's (1986) 8-step theory-evaluation model. Finally, a discussion of the limitations and implications for the study precede a brief summary that concludes the study.

Chapter Five addresses applies the new theory to the next four steps of Dubin's (1978) model, developing propositions, identifying empirical indicators, developing hypotheses, and research. Ultimately this process will answer the third research question, Can an adult learning based theory of K12 educator professional learning for technology adoption be operationalized? Following a description of each of Dubin's (1978) three steps, the propositions, empirical indicators, and hypotheses are specified for the adult learning-based theory of K12 educator professional learning for technology adoption. The chapter continues with a proposed research agenda of two research hypotheses.

## Propositions

### Dubin's Explanation of Propositions

Dubin (1978) defines a proposition as "a truth statement about a model when the model is fully specified in its units, laws of interaction, boundary and system states. Any

truth statement that can be made about such a system is a proposition" (p. 160). Propositions are truth statements about the output values of units as a result of the laws of interaction between the units being put into operation. Propositions are truth statements about the model in operation. Once a model is in operation predictions may be made about the values of the units in the model (Dubin, 1978). Another way to view propositions is as if-then statements. These statements may also be linked together, such as "If a, then b; if b, then c; if c, then d; etc. (Dubin, 1978, p. 165).

Dubin (1978) defines three types of propositional statements:

(1) Propositions may be made about the values of a single unit of the model, the value of that unit being revealed in relation to the value of other units connected to the unit in question by a law of interaction.

(2) Propositions may be predictions about the continuity of a system state that in turn involves a prediction about the conjoined values of all units in the system.

(3) Propositions may be predictions about the oscillation of the system from one state to another that again involves predictions about the values of all units of the system as they pass over the boundary of one system state into another. (A special case of this third class of predictions is the case in which the system is destroyed or modified by virtue of penetration of the system boundary. (p. 166)

To move the model toward efficiency and parsimony Dubin (1978) proposes eliminating trivial propositions, those whose returned values only generate a slight difference

from other similar propositions. This brings about a need for strategic propositions, where the values reported as an output of the model represent a critical point in the model, such as maximum, minimum, or turning from negative to positive (Dubin, 1978). Identifying and using the strategic propositions is parsimonious as well as useful in identifying values of the unit that provide extraordinary insight into the operation of the model (Dubin, 1978).

Propositions differ from laws of interaction in three ways (Dubin, 1978). One, their content and value is different; laws of interactions describe the relationship between units across a range of values and propositions provide a prediction for value of a unit with a corresponding value of another unit. Two, laws of interaction and propositions are used differently. Laws of interaction are used in theories to state the lawful interaction between units of the theory and propositions are used to predict the values of one or more units based on know the value or on or more other units. Finally, laws of interaction and propositions are asymmetrically linked. That is, propositions may be derived from laws of interaction more easily than propositions may be derived from laws of interaction (Dubin, 1978).

Dubin (1978) concludes his discussion of propositions with negative propositions that serve to negate a proposition. The logic of a negative proposition would be that if a positive proposition serves to identify the values of one or more units knowing the values of those units, then a negative proposition would state that the value of one or more units cannot be associated with the known values of the other units (Dubin, 1978).

## Propositions of the Theory

The following propositions concern the value of a single unit as it relates to other units and within the laws of interaction. In the interest of parsimony these are strategic propositions.

Proposition 1: If technology implementation in K12 education occurs, then the educators in the implementation participate in professional development.

Proposition 2: If K12 educator professional development to support technology adoption occurs, then the personal context of the participants directly influences all other units except technology implementation in K12 education.

Proposition 3: If K12 educator professional development to support technology adoption occurs, then the physical environment directly influences interpersonal context and readiness to learn.

Proposition 4: If K12 educator professional development to support technology adoption occurs, then the digital environment directly influences interpersonal context and readiness to learn.

Proposition 5: If K12 educator professional development to support technology adoption occurs, then the policy environment directly influences interpersonal context and readiness to learn.

Proposition 6: If K12 educator professional development to support technology adoption occurs, then the interpersonal context directly influences readiness to learn and transformative learning.

Proposition 7: If K12 educator professional development to support technology adoption occurs, then readiness to learn directly influences interpersonal context and interpersonal context directly influences readiness to learn.

Proposition 8: If K12 educator professional development to support technology adoption occurs, then readiness to learn directly influences transformative learning.

Proposition 9: If K12 educator professional development to support technology adoption occurs, then interpersonal context directly influences transformative learning.

Propositions may relate to the continuity of a system state that affects all of the unit values in the system (Dubin, 1978). The system states of the adult learning-based theory of K12 educator professional learning for technology adoption consists of the engagement level of the participants in the system, i.e., teachers, administrators, and facilitators. As discussed in Chapter Four, a balanced system state indicates that all participants are optimally engaged in professional learning to support technology adoption.

Proposition 10: If K12 educator professional development to support technology adoption occurs, then a balanced system state will directly influence all other units except technology adoption in K12 education.

The final type of proposition Dubin (1978) provides for is how the oscillation between system states affects units. As discussed in Chapter Four, other system states exist in the theory in which the engagement level of the system participants falls out of balance. These system states will experience lower engagement in professional learning from one or more of the system participants, i.e., teachers, administrators, and facilitators. In all cases moving to an unbalanced system state influences the units. For example, a system state with less engagement from the administrators will result in lower values for the environment units, which will result in lower values for interpersonal context and readiness to learn, which will result in lower values for transformative learning.

Proposition 11: If K12 educator professional development to support technology adoption occurs, then an unbalanced system state will directly influence all other units except technology adoption in K12 education.

This section defined the fifth step in Dubin's (1978) theory-building research model, propositions, as "if a, then b" truth statements about the units in a system. Dubin described three types of propositions, one predicting the units in the theory and two that focus on how system states impact the units. Examining the adult learning-based theory of K12 educator professional learning for technology adoption resulted in 11 propositions, 9 concerning truths

about the units and 2 additional propositions that addressed the system states. The next section addresses the empirical indicators that measure the units.

## Empirical Indicators

### Empirical Indicators Explained

Just as propositions predict the values of one or more units in the model, empirical indicators produce the values of the units (Dubin, 1978). This section provides a description of empirical indicators according to the types of units in the theory followed by the empirical indicators for the adult learning-based theory of K12 educator professional learning for technology adoption. "An empirical indicator is an operation employed by a researcher to secure measurements of values of a unit. An empirical indicator is therefore a procedure… [that] "contains both the operation of measuring and the results or value produced by this operation" (Dubin, 1978, p.182).

Dubin (1978) goes on to explain that the value produced by an empirical indicator is a numerical value, an ordinal position on a scale, or a category such as present or absent. Dubin defines the two key criteria empirical indicators, which he labels (1) operationism and (2) reliability, thusly:

(1) The operation involved in the relation between observer and the apparatus used for observing are explicitly set forth so that they may be duplicated by any other equally-trained observer.

(2) The observing operation produces equivalent values for the same sample when employed by different observers. (p. 183)

Operationism refers to the use of an instrument to provide measurement. Reliability refers to observer and instrument reliability. Only the units of a model get measured, not the laws of interaction (Dubin, 1978).

The adult learning-based theory of K12 educator professional learning for technology adoption uses enumerative units. That is, they always exist in some form in the model. Empirical indicators used to measure the units in this theory should always return nonzero values (Dubin, 1978). Other classes of empirical indicators include absolute versus relative. Absolute indicators measure unit values for which there is no uncertainty about what is being measured. This may include things like race, gender, and age, but also things on a Likert-type scale such as "I like my school," or "I like to use technology to complete administrative tasks." A relative indicator may be used to measure several different units (Dubin, 1978).

## Empirical Indicators of the Theory

The empirical indicators of the adult learning-based theory of K12 educator professional learning for technology adoption must meet Dubin's (1978) criteria of operationism and reliability as well as return nonzero values. Figure 31 shows the units and their indicators.

| Unit | | Empirical Indicators |
|---|---|---|
| 1. Technology Implementation in K12 Education | - | Catalyst Unit – technology implementation in K12 education causes system participants to engage in professional learning; must exist, activates all laws of interaction in the theory |
| 2. Personal Context | - | Perceived ease of use, perceived usefulness, experience, and voluntariness as measured by a survey (Venkatesh & Bala, 2008) |
| 3. Physical Environment | - | Perceived satisfaction of spaces, ambience, equipment, and materials as measured by a survey |
| 4. Digital Environment | - | Perceived usefulness of levels of access, connectivity, support, and virtual spaces as measured by a survey (Lu & Overbaugh, 2009; Circone, 2008) |
| 5. Policy Environment | - | Perceived usefulness of standards, policies, and practices as measured by a survey (Lu & Overbaugh, 2009) |
| 6. Interpersonal Context | - | Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey (Adams & Forsyth, 2006; (James & McCormick, 2009).) |
| 7. Readiness to Learn | - | Self-directed learner, life experience, knowing why the learning is important, authentic learning, intrinsic motivation to learn (andragogical practices) as measured by a survey (Holton, et al., 2009) |
| 8. Transformative Learning | - | Critical self-reflection, recognizing frames of reference and imagining alternatives, and dialoguing to test new ideas and resolve contested beliefs as measured by a survey (King, 1998, 2002) |

Figure 31. Empirical indicators of the theory.

As the second step in operationalizing the theory this section provided empirical indicators that return values for the units of the adult learning-based theory of K12 educator professional learning for technology adoption. The next section combines the propositions and empirical indicators to develop hypotheses that connect the theoretical model with the empirical world.

# Hypotheses

## Hypotheses Explained

This section develops hypotheses to connect the predictions of the propositions and the values of the empirical indicators to the empirical world. Dubin (1978) provides a clear definition for a hypothesis as "the predictions about values of units of a theory in which empirical indicators are employed for the named units in each proposition" (p. 206). In short, every time a unit name appears in a proposition an empirical indicator that measures the value of the unit must be substituted.

Hypotheses that mirror propositions establish a firm link between the theoretical model and the empirical world. Most of the previous steps in Dubin's (1978) theory-building research model, units, laws of interaction, boundaries, system states, and propositions help bring definition and structure to the theory. Dubin (1978) explains that if the model has been constructed properly then "an hypothesis is not an ad hoc question to be answered by research but is rather a prediction of values on units that in turn are derivable from a proposition about a theoretical model" (p. 207).

A hypothesis should be homologous with its corresponding proposition and the homology is determined by the "dimensionality of the theoretical definition of the units contained in the proposition" (Dubin, 1978, p. 207). Each empirical indicator should meet the necessary and sufficient conditions for how the unit operates in the theory. Determining the necessary and sufficient conditions of a unit in a theory is a logical operation, not an empirical test (Dubin, 1978).

Dubin (1978) provides three strategies for hypotheses construction: (a) extensive tests, (b) intensive tests, and (c) inductive tests. Extensive tests focus on testing each of the strategic propositions in the whole theory and may be the most comprehensive. Intensive tests focus more on the strategic propositions in certain areas of the theory that the researcher may specifically want to study. The inductive strategy starts with a hypothesis that yields results, then the researcher reasons back to the proposition and the theory from which it might have arisen (Dubin 1978). Dubin (1978) does not distinguish one strategy as preferred over the others.

## Hypotheses of the Theory

The adult learning-based theory of K12 educator professional learning for technology adoption contains many areas that might be researched and some that have been researched. For example, the empirical indicators for the unit personal context have been researched in the TAM3 and its predecessors TAM and TAM2. Figure 31 provides references to studies that have established values for the units of the theory. Dubin's (1978) strategies for developing hypotheses suggests that extensive tests may be the most comprehensive but in this case, not the most parsimonious. For that reason the intensive strategy will be used to formulate the hypotheses on a narrower focus area. The process units of the theory are interpersonal context and readiness to learn, and the output unit of the theory is transformative learning. These units focus on how the adult learning theories andragogy and transformative learning impact K12 professional learning for technology adoption. Figure 32 presents two hypotheses focused on how andragogical processes influences transformative learning in professional development for technology adoption.

| Proposition | Empirical Indicators | Hypothesis |
|---|---|---|
| 7: If K12 educator professional development to support technology adoption occurs then readiness to learn directly influences interpersonal context and interpersonal context directly influences readiness to learn. | Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey<br><br>Self-directed learner, life experience, knowing why the learning is important, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey | Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey directly influence andragogical practices and andragogical practices directly influence perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey. |
| 8: If K12 educator professional development to support technology adoption occurs then readiness to learn directly influences transformative learning. | Self-directed learner, life experience, knowing why the learning is important, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey<br><br>Critical self-reflection, recognizing frames of reference and imagining alternatives, and dialoguing to test new ideas and resolve contested beliefs as measured by a survey | Self-directed learner, life experience, knowing why the learning is important, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey directly influence transformative learning in using technology as measured by a survey. |

Figure 32. Hypotheses of the theory.

This section made the connection between the theoretical model and the empirical world by developing hypotheses homologous with propositions from the adult learning-based theory of K12 educator professional learning for technology adoption. The next section addresses the eighth step in Dubin's methodology, research.

## Research

The section begins with overview on Dubin's (1978) thoughts about how empirical research impacts his theory-building research methodology. It continues with a brief explanation of where empirical research fits into this theory-building research study and concludes with some ideas on a research agenda for the adult learning-based theory of K12 educator professional learning for technology adoption.

### Dubin's Stance on Theory and Research

The eighth step in Dubin's (1978) theory-building research methodology is research. Dubin begins by defining theory, or scientific models, as " … the imaginative recreation of some segment of the observable world by a theorist interested in comprehending the forms and functions of selected segments of the world …" (p. 216). Scientists use empirical research to determine if the propositions of the model do indeed mirror the observable world. Dubin notes that theory building and empirical research are "separable as distinctive operations but inseparable as necessary complementary components of scientific endeavor" (p. 217).

Dubin (1978) makes clear the value in using descriptive research to build a theory and points out that theory building is a continuous process that helps humans make sense of the world. Sense making occurs at the limits of what humans can comprehend through their senses and sensory cues, and models help clarify all of this. As research techniques and technology improve more complex theories may be confirmed (Dubin, 1978). Empirical research may be used to confirm or improve theory; Dubin (1978) argues that it should be the latter. Researchers should not forsake theory building for empirical research or the converse;

the inductive processes used in theory construction, steps 1-4 of Dubin's methodology, are as important as the deductive processes used in empirical research, steps 5-8 of Dubin's methodology (Dubin, 1978). Dubin labels this movement from the first part to the second part of the model as "an abrupt shift from a logical test of truth to an empirical test of truth" (Dubin, 1978, p. 230).

Just as Dubin (1978) recognized the distinctive operations of theory building and empirical research to test and improve a theory, so have others (Garcia, 2008; Holton & Lowe, 2007). Some used steps 1-5 of Dubin's (1978) methodology, units, laws of interaction, boundaries, systems states, and propositions (Lowe & Holton, 2005; Torraco, 2000). Holton and Lowe (2007) used steps 1-5 of Dubin's (1978) methodology to define a research process. Garcia (2008) and Tuttle (2003) used steps 1-7 of the Dubin methodology, adding the steps empirical indicators and hypotheses to their work. In all cases the researchers, like Dubin, recognized the importance of empirical research to the theory-building research process, the inseparable side, but modeled their studies to focus on the distinctive theory-building research process. This study does the same. The following section proposes the beginnings of a research agenda for the adult learning-based theory of K12 educator professional learning for technology adoption using a research framework similar to that used by Garcia (2008).

## Proposed Research Agenda

### Proposed agenda: Research question

Validating the theory resulting from this study would require the research question: Can an adult learning-based theory of K12 educator professional learning for technology adoption be validated? The breadth of the theory may require multiple studies to validate

such a question. Rather, this research agenda proposes a question that addresses part of the theory: Does readiness to learn affect transformative learning as theorized in the adult learning-based theory of K12 educator professional learning for technology adoption?

**Proposed agenda: Hypotheses**

Hypothesis 1: Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey directly influences andragogical practices and andragogical practices directly influence perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey.

Hypothesis 2: Self-directed learner, life experience, knowing why the learning is important, intellectual readiness to learn, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey directly influence transformative learning in using technology as measured by a survey.

**Proposed agenda: Research design**

The proposed research agenda's hypotheses focus on the impact of incorporating adult learning theories into professional learning for K12 educators in a technology implementation. Adding adult learning theory to professional learning is a treatment that may be studied using a one-group pretest-posttest, survey-based longitudinal design (Creswell, 2009). The pretest survey will be followed by professional development for technology adoption designed to leverage the andragogical elements of adult learning and provide for

transformative learning. At the end of a specified amount of time of one year the posttest survey will be administered and analyzed to determine if and how the participants in the model progressed in transformative learning. As professional learning continues follow-up administrations and analyses of the survey may occur after each subsequent year.

Limitations of the study include unexpected events such as leadership changes and budget cuts that might prematurely end the technology implementation and thus compromise the system state of the model. A second limitation involves possible inconsistencies in survey administration that would affect responses. A third limitation includes possible district-state policy changes that mandate other priorities force an end to professional learning to support technology adoption. The study will control for unexpected leadership changes events by emphasizing the roles played by the participants over the individuals who play them and consider how to control for other unexpected events. Policy changes that impact professional learning usually require lead-time to implement and as such may be controlled.

**Proposed agenda: Participants**

Participants will be all of the educators in a K12 technology implementation in a school who participate in professional learning. Participants will include teachers, administrators, and facilitators and, as described in Chapter Four, they may have different roles in the professional learning. As typical in schools and districts, more of the participants will be teachers, and the administrators and facilitators may participate in the professional development as learner, presenters, organizers, or a combination. The population size of participant groups in K12 schools implementing technology is small enough to include the

entire population. The average size of a K12 school faculty in the United States is about 35 (U.S. Department of Education National Center for Education Statistics, 2013)

**Proposed agenda: Variables and measurement**

Figure 33 provides the variables necessary to test the proposed research hypotheses followed by a discussion of each variable.

| Hypothesis | Variables |
|---|---|
| Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey directly influences andragogical practices and andragogical practices directly influence perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey. | - Professional Learning activities<br>- Level of andragogical practices<br>- Level of perceived efficacy of leadership, organizational culture, and collaboration |
| Self-directed learner, life experience, knowing why the learning is important, intellectual readiness to learn, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey directly influence transformative learning in using technology as measured by a survey. | - Professional learning activities<br>- Level of andragogical practices<br>- Level of transformative learning |

Figure 33. Proposed research agenda - variables required to test hypotheses.

Professional learning activities refers to what where, why, when, and how professional development activities are designed and implemented after the pretest survey. Chapter Two includes discussion about the design of professional learning for technology adoption; Chapter Four includes an implementation scenario and design specifications embedded in the units such the physical, digital, and policy environments. Measurement will

be conducted through Kirkpatrick's (1998) 4-level evaluation model of reaction, learning, behavior, and results as discussed in Chapter Two.

Level of andragogical practices refers to the six assumptions of andragogy discussed in Chapters Two and Four: self-directed learner, life experience, knowing why the learning is important, authentic learning, intrinsic motivation to learn and intellectual readiness to learn. The pretest survey will provide an indication of these levels and direction as to areas of focus in planning for professional learning to support technology adoption. Continuous measurement may occur by the pretest and posttest survey and by ongoing conversation among participants. Preparation in andragogical practices indicate the learner is ready to take on the changes necessary in a technology implementation that allow for transformative learning (Hurt, 2007; King, 2002; Parra, 2010; Potter & Rockinson-Szapkiw, 2012).

Level of perceived efficacy of leadership, organizational culture, and collaboration refers to the unit interpersonal context. The importance of these areas was discussed in Chapter Four. Adams and Forsyth (2006) measured and discussed what they called collective teacher efficacy, a construct that measures teachers' beliefs about the ability of the faculty to influence student learning. This efficacy arises out of the school structure or organizational culture, influenced by other teachers – collaboration – and leadership (Adams & Forsyth, 2006). The area of leadership includes the role of the facilitator, most importantly as the individual who holds professional learning "participants responsible for their own learning and behaviors" (Hartwig, 2000, p. 45). Measurement occurs through the pretest and posttest survey and ongoing observation and dialogue between administrators, facilitators and teachers.

Level of transformative learning refers to critical self-reflection, recognizing frames of reference and imagining alternatives, and dialoguing to test new ideas and resolve contested beliefs. The importance of transformative learning as an adult learning theory (Mezirow, 1997, 2000) that could contribute to K12 educator professional learning for technology adoption was discussed in Chapters Two and Four. Technology implementation requires teachers to make dramatic shifts in their instructional practices, and facilitators and administrators to broaden their approaches and areas of responsibility to support teachers (Cranton, 2006; King, 2002, 2004). Measurement occurs through the pretest posttest survey and ongoing dialogue between participants in the professional learning.

**Proposed agenda: Instruments**

This proposed research agenda relies on a pretest posttest follow-up survey strategy to test the hypotheses of the study. Surveys in use by other researchers could be utilized and/or used to guide the development of a new instrument. The Andragogical Practices Inventory (Holton, et al., 2009) measured 5 of the 6 assumptions of andragogy. The authors reasoned that two of the assumptions, motivation and orientation to learning (authentic learning) factored together and thus labeled them as motivation (Holton, et al., 2009). The instrument also measured 6 of 8 andragogical design elements as discussed in Chapter Two: (a) setting learning objectives, (b) climate setting, (c) evaluation, (d) preparing the learner, (e) designing the learning experience, and (f) learning activities. The instrument did not measure diagnosing learning needs and the authors eliminated collaborative planning from the inventory because it did not match the research environment (Holton, et al., 2009). The instrument shows exceptional promise for research using andragogy.

King developed the Learning Activities Survey (1998) to measure transformative learning and then adapted it for use with educational technology to account for the tremendous changes required of teachers by technology implementations (2002). Other studies developed surveys that measured elements of the interpersonal context, leadership, organizational culture, and collaboration (Adams & Forsyth, 2006; James & McCormick, 2009). The studies highlighted in this section and their surveys serve as good examples for creating the pretest posttest instrument for the proposed research agenda of the adult learning-based theory of K12 educator professional learning for technology adoption.

**Proposed agenda: Procedures**

Procedures for the proposed research agenda include the administration of the pretest, posttest, and ongoing administration of the survey, the design and delivery of the professional development and the ongoing dialogue between participants. Participants will be asked to take the survey during a faculty meeting to ensure high participation rate. Care should be taken in the development of the survey so that it is relevant, not too general and not too obscure. A panel of experts should review the survey prior to use to improve reliability (Garcia, 2008).

The procedure for design and delivery of the professional development will be influenced by the results of the pretest survey and the professional development strategies discussed in Chapters Two and Four. By the very nature of their role facilitators carry the weight of this responsibility. Professional learning will be evaluated on an ongoing basis using surveys.

Both the andragogical practices and the interpersonal context require dialogue between the participants in the system and the professional learning, including the teachers, facilitators, and administrators. Facilitators will be the key to successful dialogue as they help hold the learners responsible for their own learning: "Facilitators can be successful in doing so by consistently and actively observing program participants throughout the course of the program and then responding accordingly" (Hartwig, 2000, p. 45). All participants will maintain a personal journal reflecting their experiences in readiness to learn, interpersonal context, and transformative learning.

**Proposed agenda: Intended analysis**

The proposed research agenda will collect data for analysis in three different methods at different points in the study. The pretest survey will be administered at the beginning of the technology implementation and one year after for each year of desired analysis. The professional learning will be evaluated on an ongoing basis using surveys designed in alignment with the Kirkpatrick four-level model (1998). The facilitators, administrators and teachers will all be asked to engage in dialogue on a regular basis from the beginning of the technology implementation. Their personal journals will help them self-critique and imagine alternatives when faced with a disorienting dilemma (Mezirow, 1997). The data collected will be analyzed to test the hypotheses of the proposed research agenda.

Hypothesis 1: Perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey directly influences andragogical practices and andragogical practices directly influence perceived efficacy of leadership, organizational culture, and collaboration as measured by a survey. The proposed research agenda will test

the value of Hypothesis 1 by comparing the value of the andragogical practices portion of the pretest and posttest surveys to the perceived efficacy of leadership, organizational culture, and collaboration portion of the pretest and posttest surveys. If the values of andragogical practices and the values of leadership, organizational culture, and collaboration move in the same direction and other data sources corroborate then the researcher will conclude that Hypothesis 1 is true.

Hypothesis 2: Self-directed learner, life experience, knowing why the learning is important, intellectual readiness to learn, authentic learning, and intrinsic motivation to learn (andragogical practices) as measured by a survey directly influence transformative learning in using technology as measured by a survey. The proposed research agenda will test the value of Hypothesis 2 by comparing the value of the andragogical practices portion of the pretest and posttest surveys to the transformative learning portion of the pretest and posttest surveys. If the values of andragogical practices and transformative learning move in the same direction and other data sources corroborate then the researcher will conclude that Hypothesis 2 is true.

This concludes the proposed research agenda for the adult learning-based theory of K12 educator professional learning for technology adoption, including the "research question, hypotheses, question, hypotheses, research design, participants, variables, instruments, procedures, and intended analysis" and structured on a framework utilized by Garcia (2008, p. 211). The proposed research agenda addressed the final step in Dubin's 8-step model and the final step in operationalizing the theory. The four steps in operationalizing the theory were: propositions, empirical indicators, hypotheses, and

research. Completing these steps addresses the third and final research question of this study and concludes with an answer of yes: Can an adult learning-based theory of K12 educator professional learning for technology adoption be operationalized? The next section evaluates the theory and addresses the implications of the study and the theory for research and practice.

## Evaluating the Theory

Patterson (1986) points out that constructing and testing theories requires rigor and continuous evaluation:

> However, the assumptions or postulates of a theory do not arise out of thin air or apart from reality and experience. They are derived of developed observations and experience or from empirical research; that is, existing facts and knowledge are the bases for the assumptions and definition of a theory. (p. xx)

As discussed in Chapter Three, Patterson's (1986), eight formal criteria provide a framework with which to make judgments about a theory. Patterson reminds his readers that few, if any, theories meet all of the criteria (Patterson, 1986) and that the criteria should be a set of goals towards which to work.

(1) Importance: a theory should apply real life or behavior and to broader situations.

(2) Preciseness and Clarity: a theory should be consistent and apply data, practice, and the formation of research hypotheses.

(3) Parsimony or simplicity: a theory should remain as simple as possible without oversimplifying.

(4) Comprehensiveness: a theory should be broad and complete, even if areas of interest may be more constrained.

(5) Operationality: a theory should be able to be converted to measurable and thus, researchable concepts. Not all concepts of a theory need to be convertible, as some describe relationships among other concepts.

(6) Empirical Validity or Verifiability: a theory should convert to measurable concepts, creating a pathway that uses experience and experimentation to determine a theory's truthfulness. This construction of new knowledge in verifying a theory also includes the knowledge gained through disconfirmation of the theory.

(7) Fruitfulness: a theory should have the capacity to lead to predictions or provoke new thinking, perhaps even as alternative or opposing theory.

(8) Practicality: a theory should be usable and apply principles in a practical way (Patterson, 1986).

The following section provides additional detail about Patterson's criteria and examples of how the adult learning-based theory of K12 educator professional learning for technology adoption satisfies each criterion.

## Patterson Criteria 1: Importance

A solid theory should be significant, relevant and connected to importance in real life. The adult learning-based theory of K12 educator professional learning for technology adoption addresses professional learning for technology implementation in K12 education. As discussed in Chapter One, today's K12 students will face competition for jobs that pits them against a rising global skilled workforce and the advances of technology (Clifton, 2011; Pink, 2005). Succeeding in such an environment will require new skills and knowledge of how to use technology to complete work. Educators understand this pressure and are responding by rethinking instructional strategies and advocating the implementation of ubiquitous access to technology (Gardner, 2006; Prensky, 2013; Wagner, 2008, Zhao, 2009). This theory focuses on helping educators lead this movement. Its relevance and importance is apparent.

## Patterson Criteria 2: Preciseness and Clarity

"A theory should be understandable, internally consistent, and free from ambiguities" Patterson, 1986, p. xx). The ability to apply the theory to data and practice or the formation of research hypotheses, make predictions, and test them is a good test of the clarity of a theory (Patterson, 1986).

The adult learning-based theory of K12 educator professional learning for technology adoption is constructed with clarity and preciseness. An example of this is the participants in the system, i.e., teachers, facilitators, and administrators. As opposed to thinking about specific people these distinctions focus on the role played by the participants. Facilitators are concerned with supporting system participants engaged in professional

learning. They may be in-school, in-district or out-of-district employees. Administrators act first as the district proxy, organizing and managing according to district mandates. Teachers are those specifically engaged in the technology implementation and thus, the professional learning. Understanding these roles allows for clarity about all system participants at any given state of the system.

The first unit, technology implementation in K12 education is a catalyst and an attribute unit. It is not variable, therefore it is either there or it is not. If the unit exists, then its presence activates the laws of interaction. If not, then the system loses it integrity. If the school implements technology, then system participants engage in professional learning to support technology adoption (at some level). All of the remaining units except the first one are enumerative and variable. They exist, and in some variable quantities. All of the laws of interaction describe direct relationships between the units.

### Patterson Criteria 3: Parsimony or simplicity

A theory should remain as simple as possible without oversimplifying. Parsimony has long been accepted as a theory characteristic and may be the criterion most often compromised in theory building. Patterson attributes some of this to the complexities of the world that sometimes block out consistency and that what may be parsimonious today, might be too simplistic tomorrow (Patterson, 1986).

The adult learning-based theory of K12 educator professional learning for technology adoption employs parsimony in several ways. As discussed in Chapter Four, the laws of interaction 2-5 are determinant, meaning the relationship between 2 units may be expressed in one law instead of 4. The propositions used in Chapter Five are strategic, identifying key

points in the truth statements about one unit to others and eliminating unnecessary propositions. An argument could be made that the three units of physical, digital, and policy environment could be constructed as a single unit, thus making the model more parsimonious. However, combining the three units into one would create a collective unit, described by Dubin (1978) as useful for explaining the model but not useful for creating models that can be operationalized. This leanness of design carried forward to the development of fewer, intensive propositions rather than more, extensive, and perhaps redundant, propositions.

The way system states are described in the model is parsimonious. The system states, defined as the balance between the system's participants, teachers, administrators, and facilitators engaged in professional learning for technology adoption is either balanced or unbalanced. A balanced system state returns maximum values for all of the units in the system and an unbalanced system state returns lower than maximum value for all of the units in the system.

### Patterson Criteria 4: Comprehensiveness

A theory should be broad and complete even if areas of interest may be more constrained (Patterson, 1986). The adult learning-based theory of K12 educator professional learning for technology adoption reaches across technology implementation in K12 education to address matters of policy, the digital environment, the collegial context, leadership and other areas that do not directly connect to educational technology. It is not the entire planning model for technology implementation but it does address new learning for all system

participants in a comprehensive way. At the same time the areas of interest of the theory constrain to K12 educators engaged in professional learning for technology adoption.

### Patterson Criteria 5: Operationality

A theory should be able to be converted to measurable and thus, researchable propositions and predictions. Not all concepts of a theory need to be convertible, as some describe relationships among other concepts (Patterson, 1986). While the theoretical constructs must be precise enough to measure, being too restrictive can also limit the theory. A lack of a measurement for a concept should not necessarily preclude its inclusion in the model. The unit should be developed first, then the measurement (Patterson, 1986).

With the exception of the first unit, technology adoption in K12 education, which is a catalyst unit and must be present for the system to exist, the units and laws of interaction between them all convert to measurable concepts. Some of the units, laws and propositions of the theory cover a wide range (e.g., readiness to learn) but instruments have been developed to measure them.

### Patterson Criteria 6: Empirical Validity or Verifiability

The criteria for evaluating a theory discussed thus far focus on the rationale for the theoretical model. Empirical validity or verifiability refers to the supporting experience and new knowledge generated as a result of validating the theory. A theory should convert to measurable concepts, creating a pathway that uses experience to confirm it and to determine a theory's truthfulness. This construction of new knowledge in verifying a theory also includes the knowledge gained through disconfirmation of a theory (Patterson, 1986).

The propositions and hypotheses developed in the proposed research agenda provide examples of the theory's ability to generate new knowledge.

### Patterson Criteria 7: Fruitfulness

A theory should have the capacity to lead to predictions or provoke new thinking, perhaps even as alternative or opposing theory (Patterson, 1986). While the previous criterion, empirical validity required that the theory must be convertible to measurable concepts, fruitfulness indicates the capacity of the theory to lead to new predictions and thinking (Patterson, 1986).

The adult learning-based theory of K12 educator professional learning for technology adoption may generate new predictions and knowledge in a variety of ways. A single unit, such a policy environment, could be studied across the entire model. Predictions about the model, or components of the model, could be made at various states of balance in the system. Although this study remains focused on K12 educator professional development for technology adoption these boundaries could possibly be expanded to include other non-technology implementations and a broader range of participants.

### Patterson Criteria 8: Practicality

A theory should be usable and encourage practitioners to organize their thoughts and apply principles in a practical way. It should provide a rational framework for exploring new ways of thinking (Patterson, 1986).

The adult learning-based theory of K12 educator professional learning for technology adoption provides a vocabulary and a model for promoting the use of adult learning

principles in technology implementations. It provides entry points for teachers, administrators, and facilitators as to how they should approach professional learning. It provides the capacity for prediction regarding the units through its determinant laws of interaction.

This section used Patterson's criteria for theory evaluation as a way to determine the soundness of the adult learning-based theory of K12 educator professional learning for technology adoption, providing detail about and alignment with each of the eight evaluation criteria. This step should be viewed as a starting point, not an end-point, because "the process of theory construction, testing, modification or reconstruction, and further testing is a continuous process" (Patterson, 1986, p. xx).

## Limitations of the Study

### The Limits of Using Only One Research Paradigm

The process used to select building the methodology of the theory-building research started with determining a research paradigm. Gioia and Petre (1990) used a 2 x 2 matrix of research paradigms developed by Burrell and Morgan (1979) to point out differences between the interpretive, functionalist, radical humanist, and radical structuralist paradigms, as representing different perspectives on beliefs about phenomena, and the nature, knowledge about, and ways of studying phenomena (Gioia & Petre, 1990; Holton & Lowe, 2007). The interpretivist paradigm models a grounded theory approach of research-then-theory that is not appropriate for this study (Creswell, 2009). The radical humanist and radical structuralist paradigms are both based on critical theoretical approaches and, while important, do not

reflect the needs of this study (Gioia & Petre, 1990). Eliminating the other three paradigms placed this study in the functionalist approach. Gioia and Petre (1990) advise against mixing the paradigms because of difficulties with methods, vocabulary, goals and assumptions even as they suggest that awareness of multiple paradigms may be useful (Gioia & Petre, 1990).

Selecting the functionalist approach made selecting Dubin's model an easy choice for theory building and limited the use of other approaches. Others advocate for the use of multi-paradigm theory-building research methodologies (Gioia & Pitre, 1990; Lynham, 2000b; Storberg-Walker, 2006; Torraco, 2004; Upton & Egan, 2010). Lynham (2000) points out that other theory-building methods, such as case study, grounded theory, interpretive theory, and action learning theory, while offering a variety of techniques and approaches may be difficult to replicate. Excluding these approaches and focusing on Dubin's methodology, while a fit with Patterson's criteria of practicality and fruitfulness, may be a limit of this study.

### Failure to Validate the Theory through Empirical Research

Those who write about theory-building research always connect the usefulness and soundness of the work back to validating the theory through research that connects the theory constructs to the empirical world (Dubin, 1978; Lynham, 2000, 2002a, 2002b; Patterson, 1986; Reynolds, 2007; Storberg-Walker, 2003; Van de Ven, 1989). While recognizing the importance of empirical validation others realize that the undertaking of constructing and conceptualizing a theory may be separate from operationalizing and validating a theory and produced studies that left the step of validation for future work (Garcia, 2008; Holton & Lowe, 2007; Lowe & Holton, 2005; Lynham 2000a; Storberg-Walker, 2004; Toracco, 2000; Tuttle, 2003). While this study employed methodologies used by others it must be recognized

that the failure to validate the adult learning-based theory of K12 educator professional learning for technology adoption is a limitation. All theories improve through testing and validation. This one is no exception.

### The Risk of Using the Model to Make Predictions about Technology Implementations in K12 Education

This model clearly focuses on K12 educator professional learning for technology adoption and its catalyst is the unit technology adoption in K12 education. This limitation concerns two areas: (a) the model should not be used as a comprehensive planning model for all aspects of a technology implementation, and (b) while parsimonious, the construction of unit one may be limiting. Each will be addressed in turn.

This theory reaches across the technology implementation to address areas that might be considered as beyond professional learning such as the digital and policy environments, leadership, and the organizational culture. Clear support exists for addressing these topics in the realm of professional learning and even in considering the failure to address these topics as barriers to an implementation's success (Cottle, 2010; Kopcha, 2012; Lu & Overbaugh, 2009; Oliver et al., 2012). In this way the theory's broad perspective on professional learning provides comprehensiveness and fruitfulness, two of Patterson's evaluation criteria, but it should not be used as the only model for comprehensive planning of or making predictions about technology implementations. This model addresses K12 educator professional learning for technology adoption and should not be extended to other areas without careful consideration.

The construction of unit one, technology adoption in K12 education, provides excellent parsimony. As an enumerative unit it must exist in some value. As an attribute unit it either exists or it does not, there are no variations. Therefore, the unit must exist in order for the system to exist, however, it has no variation. As a catalyst, unit one has the special purpose to activate the laws of interaction between other units. Therefore, for the system to exist, technology implementation in K12 education must exist. Because it exists, the other units of the system interact. In plain language, if a school implements technology, then educators in the school engage in professional learning. While efficient, this limits the use of the unit because technology implementation in K12 education may not exist in variable values. What if the implementation is only for one class or grade level or one teacher? Would this change the way the model functions?

## Implications

### Implications for Adult Learning Theory and K12 Educator Professional Learning to Support Technology Implementation

This section focuses on two areas of importance for the findings of this study in K12 education: one, the introduction of adult learning theory addresses the unique learning needs of K12 educators and opens the door for the inclusion of adult learning principles in other K12 educator professional learning models. Two, the theory resulting from this study provides useful ways to consider educator professional learning in the context of technology implementation.

As discussed in Chapters One and Two, K12 education focuses so much on student learning sometimes educator learning gets confused, minimalized, or even lost. Nowhere is

this more evident than in the literature on educator professional learning where, ultimately, the test of how well an educator learns is how well that educator's students learn (ISTE, 2008; Learning Forward, 2011; Lawless & Pellegrino, 2007; NSDC, 2009; Guskey, 2002). Therefore, the end goal of educator learning always remains focused on how students learn in what Knowles labeled "the millstone of pedagogy" (Knowles, 1973, p. 42). These ideas about the prominence of student learning needs over educator learning needs get locked into the collective thinking of society through the "apprenticeship of observation" where, by virtue of having attended school, we think we understand what is good for students, how to teach, and by implication, what is good for teachers (Lortie, 2002). These entrenched beliefs about pedagogy are an excellent example of Foucault's description of the use of power, that those who perpetuate the system are unwittingly exercising the power that constrains them (Brookfield, 2002; Foucault, 1984). All of this makes focusing on the needs of K12 educators to support transformative learning a difficult task at best (Ertmer, 2005).

This study utilizes two prominent adult learning models andragogy (Knowles, 1973) and transformative learning (Mezirow, 1997) to break the mold and provide for the unique needs of K12 educators as adult learners. The exercise of condensing the two models in Chapter Two provided a framework for looking at andragogy as a set of practices or assumption about adult learners and conceptualizing transformative learning as a three-step model of critical self-reflection, recognizing frames of reference and dissonance, and dialoging with others to resolve dilemmas. Combining the two theories together provided an impetus for creating a new theory, a process utilized by others (Brown, 2006; Kiely, et al., 2004).

Technology implementations can be a catalyst for looking at new ways of educator learning (Beach, 2012; Griffin, 2003; Matzen & Edmunds, 2007; Sandholtz et al., 1997). Using the adult learning-based theory of K12 educator professional learning for technology adoption provides new ways to think about professional learning by building a base around the unique personal context of individuals and an appropriate physical, digital, and policy environment that contribute to interpersonal contexts and a collective readiness to learn. All of this provides a much stronger starting point for supporting transformative learning. The model could support planning efforts in K12 educator professional learning and help theorists and researchers make predictions about various professional learning programs and strategies.

## Implications for Theory-Building Research and HRD

This study replicates a theory-building research methodology employed or advocated by others, and as such adds to the literature (Dubin, 1978; Garcia, 2008; Holton & Lowe, 2007; Lowe & Holton, 2005; Lynham 2000a; Storberg-Walker, 2004; Toracco, 2000; Tuttle, 2003). Patterson (1986), who provided the criteria by which theory could be evaluated, also provided a very clear definition of a theory and a reason for building theories. Patterson (1986) writes:

> A theory organizes, interprets, and states in the form of laws or principles, the facts and knowledge in an area or a field. The organization or arrangement of what we know makes possible a systematic description from which explanations and predictions can be derived that can then be systematically tested. Theories are

invented or constructed for these purposes; they do not exist by themselves somewhere waiting to be discovered. (Patterson, 1986, p. xix)

Thus, we build theories because they help us understand the real world; we operate on personal theories in practice every day (Lynham, 2002b). Promoting the practice of theory-building research is necessary and important for the field of HRD to grow (Holton, 2002).

This study represents a somewhat rare case of applying HRD knowledge, theories, and research techniques to the field of K12 education. In doing so this study circumvents the challenge faced by K12 education theorists of feeling compelled to place the question "How does this help students learn?" at the forefront of every study and every recommendation. This study proceeded without being weighed down by being anchored to the millstone of pedagogy (Knowles, 1973).

## Implication for Changing Boundaries and System States

The strict boundaries of this theory, K12 education, technology adoption, educator, and professional learning provide parsimony and at the same time invite HRD theorists to consider the possibilities of loosened or changed boundaries. Could the model support professional learning for K12 educators in any context, not just in a technology implementation (a loosened boundary)? One obvious question would be about the relative importance of the digital environment for professional learning not in a technology implementation.

What would happen, for example if the boundaries and system states changed to replace K12 educators with employees in a business experiencing a technology implementation where the technology impacted their daily activities beyond administrative

tasks (just as technology implementation in K12 education impacts the daily activities of teachers). The employees who would implement the technology in their work would replace teachers as system participants. Would the model hold? Other possibilities exist to explore shifting boundaries and systems states. The keys to the adult learning-based theory of K12 educator professional learning for technology adoption lie in its ability to support andragogical practices and transformative learning.

## Conclusion to the Study

This study sought to apply the following steps of adult learning principles to K12 educator professional learning for technology adoption, i.e., to develop, conceptualize, and operationalize a new theory. Those three steps were completed by the study and resulted in the affirmative for each of the three research questions.

Chapter One introduced the study and provided the purpose and need. A discussion about the skills K12 students in the United States need to compete in a global and technological economy established the need for schools to use technology to help students learn 21st century skills. Technology adoption, teacher professional development, and adult learning theory models were introduced and a gap identified where the models of K12 educator professional development do not explicitly include adult learning principles.

Chapter Two reviewed the literature pertinent to the study. Areas of focus included technology adoption models, adult learning theory, K12 educator professional development, and theory-building research.

Chapter Three described the methodology of the study. Starting with the three research questions and the research paradigm, the chapter described the steps in Dubin's

(1978) 8-step theory-building research methodology and provided a brief overview of Patterson's (1986) theory evaluation criteria.

Chapter Four began the theory-building process by developing steps 1-4 of Dubin's (1978) methodology: units, laws of interaction, boundaries, and system states. This chapter answered the first two research questions in the affirmative: (1) Can adult learning theory be used to develop a theory of educator professional learning for technology adoption? and (2) Can adult learning theory be used to conceptualize a theory of educator professional learning for technology adoption?

Chapter Five continued the theory development process by operationalizing the theory using steps 5-8 of Dubin's methodology: propositions, empirical indicators, hypotheses, and research. Instead of conducting research on the theory in step 8 a research agenda was proposed. The theory was evaluated using Patterson's (1986) 8-step criteria. The chapter concluded by discussing the limitations and the implications of the study.

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