A Revised Measure of Ely's Conditions of Change: Initial Psychometric Properties of the Implementation Profile Inventory II

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ABSTRACT

This study provided reliability and validity evidence to substantiate the Implementation Profile Inventory II's (IPI-II) use as a measure of a user's perceptions of Ely's (1990a) eight conditions of change. To establish the psychometric properties of the IPI-II, three alternative factor structure models for Ely's conditions were compared. A confirmatory approach was used for the analysis of the evidence. A four-factor structure hypothesized by Ensminger et al (2004) appears to fit reasonably well; however, this study provided stronger evidence for a fifth underlying construct as a better model for the IPI-II's structure in a sample of 252 university faculty and staff. Perceptions of conditions that influence implementation of innovations are important measures of success and can serve as a planning guide for the instructional designer (Ely, 1990a, 1990b, 1999a, 1999b; Ensminger & Surry, 2002; Ensminger, 2005). The IPI-II is a revised scale (Ensminger & Surry, n.d.) designed to measure a user's perceptions of the importance of Ely's eight conditions of change. Psychometric information was obtained and reported on the measure's dimensionality, reliability, and validity. Recommendations are offered to facilitate the revision of questionnaire items to achieve a stable, well-defined solution for the factor structure (dimensionality) of the IPI-II. This study represented the first psychometric evaluation of the IPI-II and the first confirmatory study in the development cycle of the Implementation Profile Inventory.

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GENERAL AUDIENCE ABSTRACT

This study provided reliability and validity evidence to substantiate the Implementation Profile Inventory II's (IPI-II) use as a measure of perceptions of Ely's (1990a) eight conditions of change. Perceptions of conditions that influence the decision to use a new technology are important measures of success and can serve as a planning guide for the instructional designer (Ely, 1990a, 1990b, 1999a, 1999b; Ensminger & Surry, 2002; Ensminger, 2005). The IPI-II is a revised instrument (Ensminger & Surry, n.d.) designed to measure a user's perceptions of the importance of Ely's (1990a) eight conditions of change to their decision to use a new technology. These eight conditions are Dissatisfaction with Status Quo, Knowledge and Skills, availability of resources, availability of time, a rewards or incentives program, participation in the form of shared decision making and communication, visible and vocal commitment by key players and stakeholders, and leadership that provides encouragement and support for the new technology. Confirmatory Factor Analysis (CFA) was the primary statistical procedure used to determine the ability of the IPI-II to accurately measure perceptions in a sample of 252 university faculty and staff. Recommendations are offered to facilitate the process of revising the IPI-II to increase the reliability of the results yielded by the instrument. This study represents the first psychometric evaluation of the IPI-II and the first confirmatory study in the development cycle of the Implementation Profile Inventory.

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Chapter 1

Introduction

Researchers in the instructional design and technology (IDT) field seeking to gain a clearer understanding of how innovations are successfully implemented have employed Ely's (1990a) eight conditions of change to explore and explain factors that might facilitate implementation for innovations in a variety of settings to explore. These conditions are thought to be present across cultures, disciplines, and organizations where educational technology innovations have been successfully implemented.

Prominent researchers in the IDT field, contend that implementation is a design phase that is often under-emphasized by instructional designers (Ely, 1999a; Ensminger & Surry, 2002; Ensminger, 2005; Reiser & Dempsey, 2012). Evidence from multiple studies suggests it is a successful implementation strategy, more so than a well-designed product, that is critical to achieving desired outcomes (Berman & McLaughlin, 1976; Berman, 1981; Burkman, 1987). User perceptions of conditions that influence implementation of innovations are an important measure of success and can serve as a planning guide for the instructional designer (Ely, 1990a, 1990b, 1999a, 1999b; Ensminger & Surry, 2002; Ensminger, 2005).

Surry and Ensminger (2004) set out to develop an instrument to help 'change agents' measure how important each of Ely's (1990a) conditions is to an individual's decision to implement an innovation; hoping to provide an accurate picture of a user's perceptions of the change environment, which is crucial for designing an implementation plan. At the time, tools to assess the importance of conditions that facilitate implementation of innovations were sparse; thus, there was a need for a reliable, accurate, versatile, psychometric instrument to assess conditions

that support change at the individual and organizational level. Their initial efforts resulted in a version of the Implementation Profile Inventory (IPI-I), an instrument designed to measure Ely's (1990a) eight conditions that facilitate implementation for innovations in a variety of settings.

The IPI-I was piloted in 2003 (Ensminger, Surry, Porter, & Wright, 2004) and a employed by Ensminger (2005) in his dissertation. The original exploratory study (Ensminger et al., 2004) resulted in a hypothesized four-factor structure underlying Ely's eight conditions, in addition to providing validity evidence from multiple sources for the IPI-I.

Results from Ensminger's (2005) study supported the IPI-I as a useful research instrument and a helpful tool for the researcher and practitioner when measuring perceptions of the importance of Ely's (1990a) eight conditions. The IPI-I: Implementation Profile Inventory, first generation, was an important beginning to the assessment of Ely's (1990a) model and has undergone more psychometric evaluation than any previous instrument used to assess Ely's eight conditions (Ensminger, 2005). However, analyses of the instrument showed some weaknesses related to the forced-choice format of the measure, which resulted in a user's response being dependent on ranking another condition.

The analyses of these early studies (Ensminger et al., 2004; Ensminger, 2005) subsequently led to significant revisions of the IPI-I. The goal of these revisions was to improve the design of the instrument in an effort to more accurately and parsimoniously describe user's perceptions of a supportive change environment. These revisions resulted in the development of a second edition of the IPI and a need for further examination of the instrument's psychometric properties.

Problems Addressed by the Study

The IPI-II: Implementation Profile Inventory, second generation, is a psychometric instrument purported to be a comprehensive measure of user perceptions of Ely's (1990a)

conditions that influence implementation of educational technology innovations. The developers revised the IPI-I and generated its successor, the IPI-II. However, the IPI-II has some obvious problems. The problems are the IPI-II is a revised scale, no reliability or validity evidence has been published on the IPI-II, and the instrument has not been used in research (D. Ensminger, personal communication, May 12, 2016).

Purpose of the Study

The purpose of the current study was to provide reliability and validity evidence to substantiate the IPI-II's use as a measure of a user's perceptions of Ely's (1990a) eight conditions of change. The current study represents the first use of the IPI-II in research and the first systematic review of the instrument's psychometric properties. This study addressed the need to develop reliability and validity evidence and examine those psychometric properties for the IPI-II, a revised measure of Ely's (1990a) eight conditions of change (personal communication from Ensminger, May 2015).

The current study investigated the degree to which the IPI-II actually corresponds to the hypothesized four-factor structure (details of the four factors can be found in Table 7 in Chapter Three) from the original study (Ensminger et al., 2004), in addition to examining the instrument's fundamental psychometric issues of reliability and validity. The process, which led to revision of the IPI, invites development of further validity evidence in order to complete the research cycle in the scale construction process (Furr, 2011). No existing instruments developed to measure Ely's (1990a) conditions, which influence implementation of educational technologies, were found that had been subjected to the methodological rigor of a confirmatory factor analysis as a technique to obtain and report psychometric information.

Significance of the Study

Over the past thirty-five years, there have been numerous qualitative, quantitative, and mixed methods studies in the IDT field using Ely's (1990a) conditions as a theoretical framework and guide for research, in a variety of organizational settings focused on implementation of innovations. Evaluating dimensionality, along with reliability and validity evidence of the IPI-II benefits the field of IDT by providing psychometric properties for a revised measure of Ely's eight conditions of change. Investigating the underlying factor structure of Ely's (1990a) eight conditions of change are important theoretical issues, enabling and facilitating interpretive arguments which can be used to make data driven decisions related to conditions that facilitate implementation of educational technology innovations (Ensminger & Surry, 2002; Kane, 2001).

The focus on the often under-emphasized implementation stage of instructional design models (Ely, 1999a, 199b; Ensminger & Surry, 2002; Ensminger 2005; Reiser & Dempsey, 2012), would further contribute to the field of IDT by providing a reliable and versatile instrument to aid in the understanding of and planning for successful innovation implementation. Examining non-instructional educational innovation variables, specifically Ely's (1990a) eight conditions, extends the literature addressing Ely's conditions, familiarizing instructional designers with these eight conditions and their underlying relationships and provides insights, which lead to hypothesis-formation for future studies in the field.

Research Question

The key question of the current study was: What are the psychometric properties of the Implementation Profile Inventory II, a revised measure of Ely's conditions of change? In order to answer the key question, three sub questions were used to guide the development and examination of reliability and validity evidence:

RQ1a: What psychometric information can be obtained from an analysis in which the four-factors hypothesized to underlie Ely's eight conditions were measured using 49 questionnaire items?

RQ1b: What psychometric information can be obtained from an analysis in which Ely's eight conditions were measured using 49 questionnaire items?

RQ1c: What psychometric information can be obtained from an analysis in which the four higher level factors and Ely's eight conditions were simultaneously measured using 49 questionnaire items?

Theoretical Foundation of the IPI-II

Developers of the IPI-II, Daniel Surry and David Ensminger, are outstanding researchers in the IDT field. Surry and Ensminger devoted research to assessing the importance of conditions influencing the implementation of educational technology through the five phases of the instructional design process: Analysis, Design, Development, Implementation, and Evaluation (ADDIE). Surry and Ensminger, along with other prominent researchers in the IDT field, contend that implementation is a design phase often under-emphasized by instructional designers (Ely, 1999a, 199b; Ensminger & Surry, 2002; Ensminger 2005; Reiser & Dempsey, 2012). Ely (1990a) argued that implementation of educational technology innovation is a complex process requiring a facilitative environment, specific knowledge, and targeted efforts by all individuals involved.

> Implementation can be seen as the last step in the portability process and all the careful efforts that have gone into designing and adapting a product will come to no results if implementation does not occur 'Implementation consists of the process of putting into practice an idea, program, or set of activities new to the people attempting or expected to change' (Fullan, 1982, p. 54 as cited by Ely, 1990a) (Ely, 1990a, p. 2).

A giant in the field. Surry and Ensminger's research has been heavily influenced by the work of Donald Ely. Dr. Ely began his career in higher education at Syracuse University in 1956. He was widely acclaimed as a pioneer in instructional technology. After four decades of research, Donald Ely leaves a legacy of research and shared understanding of conditions influencing implementation of educational technologies—his classical framework of eight conditions that facilitate implementation of educational technology innovations (Ely, 1978; Ely, 1990a, 1990b, 1999a, 1999b: Ely & Plomp, 1976). Ely's investigations into conditions that facilitate implementation of innovations resulted in eight conditions present across cultures, disciplines, and organizations where educational technology innovations have been successfully implemented. A brief summary of Ely's (1990a) eight conditions that facilitate the implementation of educational technology innovations, with operationalized definitions, can be found in Table 1.

Table 1

Definitions of Ely's Eight Conditions that Facilitate the Implementation of Educational Technology Innovations (Ely, 1990a)

Condition	Definition
1. Dissatisfaction with the Status Quo	A dissatisfaction with things as they are; necessity to change.
2. Knowledge and Skills Exist	Knowledge and skills must be present for change to occur; users must possess some level of competence as regards the innovation.
3. Resources are Available	Tools and relevant materials should be easily accessible.
4. Time is Available	Paid time for training, planning, evaluating, practicing; time is also a resource, but should be considered as a distinct condition that must be available for change to occur.
5. Rewards or Incentives Exist for Participants	Incentives vary for individuals and may take the form of more resources, more pay, professional opportunities, personal challenge, etc. Incentives and rewards, intrinsic or extrinsic,

	should exist in some form.
6. Participation is Expected and Encouraged	Shared decision-making, communication among all parties involved, and representation where individual participation is difficult; individuals affected by the change need to have input regarding the innovation.
7. Commitment by Those Who are Involved	Firm visible evidence that there is endorsement and continuing support for implementation by key players and other stakeholders is necessary.
8. Leadership is Evident	Two-pronged leadership is necessary: (a) by the leader of the organization and (b) by the project leader involved in day-to-day activities; leaders provide encouragement, insure that training and materials are available, are accessible, and communicate enthusiasm for the innovation.

Numerous studies of change and implementation of educational technology innovations have used Ely's framework as a guide for exploring and evaluating these conditions in varied settings. Research in the IDT field has found, when conditions that facilitate implementation of an innovation are perceived as important and present by those using the innovation, these conditions contribute to the optimal uptake of the innovation (Buchanan, Sainter, & Saunders, 2013). Given the importance of users' perceptions of conditions in the environment, which serve to support implementation of an innovation, it is critical for change agents to consider users' perceptions when planning the implementation phase of instructional design.

Research Methods

The objective of the current study was to provide reliability and validity evidence for the revised IPI and to examine underlying factor structures of a measure of Ely's eight conditions of change. This study was conducted using an online survey method to collect data in a higher education setting with the goal of providing a set of observations for confirmatory factor analysis (CFA). CFA is the primary statistical procedure used in the current study to obtain psychometric

information. CFA is a kind of Structural Equation Model (SEM). SEM is a set of statistical techniques for testing a theory by providing elaborate box-and-arrow models called path diagrams (Giles, 2002). The motivation for choosing CFA as the statistical method was the need to investigate IPI-II's dimensionality going forward with a clear factor structure for Ely's eight conditions of change in addition to obtaining other facets of validity and reliability.

Definition of Key Terms

In order to establish a common understanding, context-specific definitions of terms and concepts are provided below. The definitions are gleaned from recognized scholars in the field of IDT and psychometrics.

Confirmatory factor analysis (CFA) – "is a type of structural equation modeling (SEM) that deals specifically with measurement models—that is, the relationships between observed measures or indicators (e.g., questionnaire items) and latent variables or factors. A fundamental feature of CFA is its hypothesis-driven nature. Unlike its counterpart, exploratory factor analysis (EFA), CFA requires the researcher to pre-specify all aspects of the model. Thus the researcher must have a firm a priori sense, based on past evidence and theory, of the number of factors that exist in the data, of which indicators are related to which factors, and so forth" (Brown, 2015, p. 1).

Construct – the "concept or characteristic that a test is designed to measure" (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014, p. 11). When referencing relationships between indicators (measures of constructs) and the construct, CFA uses the terms *factor*, latent traits, latent variables or characteristics.

Dimensionality – references how many psychological features or attributes a test measures. An instrument's dimensionality is a fundamental consideration in instrument development, evaluation, and use. The three key questions related to dimensionality are: (1) is the test unidimensional, measuring one attribute, (2) is the test multidimensional, measuring multiple correlated dimensions, and (3) is the test multidimensional, measuring multiple uncorrelated dimensions (Furr & Bacharach, 2014).

Implementation – "…the process of putting into practice an idea, program, or set of activities new to the people attempting or expected to change" (Fullan, 1982, p. 54); or more succinctly put by Rogers "Implementation occurs when an individual (or other decision-making unit) puts a new idea into use" (Rogers, 2003, p. 20).

Innovation – "…an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12).

Psychometric properties – Psychometric properties of an instrument refer to measures of validity and reliability that provide evidence for confidence in results and enable decisions to be made based on results. Psychometrics refers to "any branch of psychology concerned with psychological measurements" (Jones & Thissen, 2007, p. 1). A psychometrician is a person who designs, scores, and analyzes data from measures of cognitive and non-cognitive psychological attributes (latent traits).

Assumptions and Limitations

An assumption of the current study was that Ely's (1990a) model of change captures constructs and variables of interest to the IDT field and is applicable to a higher education setting. Additionally it was assumed content and face validity of both editions of the IPI are the same (D. Ensminger, personal communication May 12, 2015). A limitation of this research was

found in the method of data collection. The data were collected through a self-reporting survey, considered an accepted limitation in research (Creswell, 2009). The data were collected through a survey accessible via the internet, and use of technology may create a response bias toward higher education employees more comfortable and favorably disposed toward innovations (Creswell, 2009; Fowler, 2002).

Overview of the Study

Conditions that facilitate implementation of innovations have been identified and explored in multiple studies. These conditions are of particular interest to instructional designers as they focus on the implementation phase of ADDIE. Chapter One provided an introduction to Ely's (1990a) comprehensive model for change conditions, highlights of Surry and Ensminger's work focused on measuring Ely's eight conditions of change, and a brief discussion of the methodology.

Chapter Two explored the broad family of theories on which Donald Ely built his conditions of change framework, along with a synthesis of prominent IDT field-related literature surrounding Ely's (1990a) eight conditions of change. Additionally, background on the development of the IPI-I and IPI-II scales, the nature of psychometrics and the fundamental psychometric issues that can be explored using CFA, were presented.

Chapter Three was a discussion of the methodology used to collect and analyze data. The IPI-II instrument was used to measure university employees' perceptions of the importance of Ely's (1990a) conditions when implementing a new learning management system (LMS). The data collected in the survey represented university employees' perceptions of the importance of Ely's eight conditions to their decision to implement a new LMS. A description and analysis of the hypothesized four-factor structure underlying Ely's eight conditions, which emerged from the

Ensminger et al. study (2004), along with specifications for the factor structures of three alternative models, were presented. The data were analyzed using CFA, a form of structural equation modeling which includes a factor analysis followed by a path analysis.

Chapter Four presented the results of the analysis of the data and how the data answered the research question. The research design included the use of the IPI-II as the instrument to collect input from employees within a higher education setting. The hypothesized four-factor structure underlying Ely's eight conditions evaluated in this study was identified in the original IPI-I studies (Ensminger et al., 2004). The reasonableness of the hypothesized four-factor structure was assessed by comparing it with three plausible alternative factor structures to test the fit with actual data gathered from a sample of university faculty and staff on the revised IPI-II.

Chapter Four included the descriptions of demographics of the sample, item response data (minimum, maximum, mean/difficulty, discrimination, and SD), and descriptive statistics for parameter estimates (questionnaire items' loading on the factors) as additional evidence of an instrument's psychometric properties (Furr & Bacharach, 2014). Specifications of the three alternative factor structure models are presented along with their interpretation and output reports.

Chapter Five included discussion of the overall adequacy of the hypothesized four-factor structure (Ensminger et al., 2004) and the degree to which it is a good representation of the IPI-II's internal structure as a measure of Ely's eight conditions of change. More importantly, evidence for alternative factor structures for Ely's eight conditions emerged and was discussed. Implications of the results for the research question and each sub question were discussed. Chapter Five also presented suggestions for the 49 questionnaire items and possibilities for further research.

Chapter Two

Review of the Literature

Chapter Two builds a contextual framework for the study by synthesizing relevant research and theories, which were key sources for describing Ely's (1990a) eight conditions facilitating implementation of educational technology innovations and their evolution (Appendix A). Additionally, the importance of a psychometric instrument's dimensionality as it relates to development, reliability, and validity were presented. A review of the literature was presented in four areas: (a) literature related to the theoretical foundations of Ely's framework in the areas of educational change and the influence of Rogers' (1962) innovation-decision process, (b) studies of Ely's eight conditions, (c) development of the Implementation Profile Inventory scales (I and II), and (d) the use of confirmatory factor analysis (CFA) to obtain and evaluate the psychometric properties of a revised instrument.

Change and Innovation

> "A theory's adequacy is judged in large measure by the scope and diversity of the phenomena which it can successfully explain." John Stuart Mills, Utilitarianism, 1863, p. xiv

Ely's framework (1990a) is grounded in theory drawn from traditions in classical change theory. A key element in examining fundamental psychometric properties of an instrument is the clear, operationalized definitions of the constructs to be measured and the soundness of the theories upon which they are founded. In order to understand Ely's eight conditions that facilitate the implementation of educational technology innovations and Ensminger et al.'s (2004) hypothesized four underlying factors, it is vital to understand leading theorists of social change at the time Ely was developing his framework.

Ellsworth's (2000) research suggested that educational change could trace its roots to two "philosophical ancestors" (p. xvii), diffusion of innovations and general systems theory. Ely

clearly identifies the change models and key components, which informed his framework in the article, "Conditions that Facilitate the Implementation of Educational Technology Innovations (1990a). Table 2 organizes these influential theories by major change perspective.

Table 2

Major Perspectives Informing Ely's Framework for Conditions that Facilitate the Implementation of Educational Technology Innovations (1990a)

Principal Author(s)	Name and Date of Change Model or keystone publication	Perspective
Everett Rogers; Rogers & Shoemaker	Diffusion of Innovations (1962); Communication of Innovations: A Cross-Cultural Approach (1971)	Diffusion and adoption of the innovation
Hall & Loucks; Hall & Hord	A Developmental Model for Determining Whether Treatment is Actually Implemented (1977); Concerns-Based Adoption Model (CBAM) (1988)	Pre-implementation issues and levels of use
Fullan & Pomfret	Research on Curriculum and Instruction Implementation (1977)	Implementation
Fullan; Fullan & Stiegelbauer	The Meaning of Educational Change (1982); The New Meaning of Educational Change (1991)	The change agent and implementation
Havelock	The Change Agent's Guide to Innovation in Education (1973)	Role of the change agent in the implementation process
Berman & McLaughlin	Implementation of Educational Innovation (1976)	Implementation and change agent programs
Havelock & Huberman	Solving Educational Problems (1978)	Resistance factors
Mayhew	How Colleges Change: Approaches to Academic Reform (1976)	Resistance factors
Zaltman & Duncan	Strategies for Planned Change (1977)	Resistance factors

Change scholars, Zaltman and Duncan, were highly influential in shaping Ely's framework for conditions, which support change through their studies of planned change and dominant features of success and failure. Zaltman and Duncan (1977) argue the most difficult issue in studying and understanding change is adequately defining the concept of change.

> Many things, perhaps all things, are always in some state of fluctuation; thus in some absolute sense 'things are always changing.' Certainly when talking about human behavior one can make the case that most behavior fluctuates. …Given that behavior is always fluctuating, what differentiates change from the status quo? What constitutes a significant modification or alteration in behavior that we can call change? …in this book, we define change at the individual and system level as an alteration in the way an individual or group of individuals behave as a result of an alteration in their definition of the situation" (pp. 7-9).

Zaltman and Duncan (1977) define innovation "as a subset of change that is characterized by its being an entirely new situation or phenomenon that the individual, group, or organization is encountering" (p. 13). Ely conceded (1978) that innovation is often considered to be synonymous with change; however, makes the distinction that an innovation can exist independent of the process of change. "An innovation is an idea, practice, or object perceived as new by an individual" (p. 151). It is only when the individual or organization begins implementation of the innovation that the change process occurs.

The concepts of innovation and change have a symbiotic relationship, which have resulted in a large body of relevant research to the field of IDT. Theories of change predominated the literature through the 1970s (Fullan & Pomfret, 1977; Hall, 1974; Hall & Loucks, 1977; Havelock, 1973; Havelock & Huberman, 1977; Zaltman & Duncan, 1977). "Diffusion of innovations has the status of a bastard child with respect to the parent interests in social and cultural change: too big to ignore but unlikely to be given full recognition" (DeFleur, 1966, p. 254). Rogers' (1962) seminal work, Diffusion of Innovations (DOI), along with four subsequent

editions (1975, 1983, 1995, 2003) is responsible for firmly establishing theories of diffusions' rightful place in the pantheon of change theory.

Diffusion of innovations (DOI). DOI was the product of Rogers' 1957 research on the diffusion of agricultural innovations and the change that occurred from using, or not using, the innovation. This study of the consequences of an innovation developed into a deep, rich, meaningful study of change and the theories surrounding social and cultural change culminating in, what is now known as, the DOI model. This model also serves as a meta-theory for change as a consequence of an innovation and is held in high regard in the IDT field and across multiple disciplines. "Diffusion research is thus emerging as a single, integrated body of concepts and generalizations, even though the investigations are conducted by researchers in several scientific disciplines" (E. M. Rogers & Shoemaker, 1971, p. 41). Rogers' model (1962) has been validated extensively and is seen as one of the most popular frameworks for studies investigating adoption and diffusion of technology innovations across disciplines (Dooley, 1999; Sahin, 2006; Stuart, 2000).

The DOI theory is organized around three big ideas and how they relate to the rate of diffusion: (a) Attributes of the innovation, (b) Characteristics of adopters, and (c) innovation-decision process. Rogers (1995) considered it a dangerous oversimplification to approach an innovation strictly from the analysis of the differences in the innovation. He felt much more investigation was needed in the area of how properties of the innovation are perceived. Rogers (1995) cited the need for a standard classification scheme, which would allow these attributes to be measured and described in universal terms.

Rogers' in-depth exploration of the characteristics of adopters resulted in a manageable number of adopter categories, which has served to guide decades of important and informative

research for scholars and practitioners alike: (a) Innovators, (b) Early Adopters, (c) Early Majority, (d) Late Majority, and (e) Laggards. Data collected from diffusion research, from a variety of systems in many countries, have contributed to a body of evidence supporting the generalization that "adopter distributions follow a bell-shaped curve over-time and approach normality" (Rogers, 2003, p. 275). These categories serve as a lens for identifying and measuring behaviors of individuals crucial in the diffusion process.

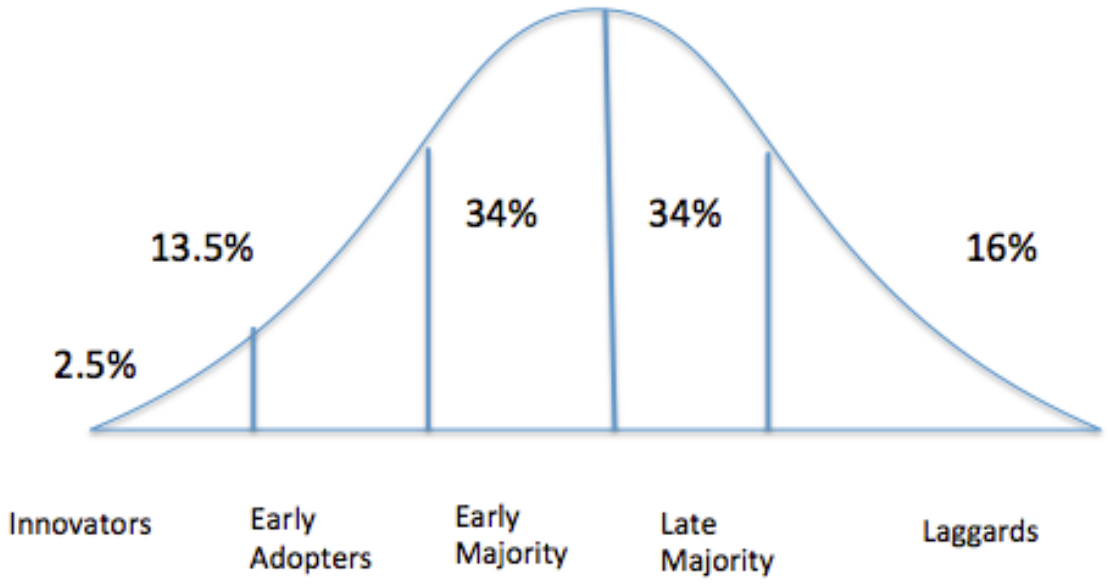

Figure 1. Rogers' adopter classification system and the normal adopter distribution (Rogers, 2003).

The innovation-decision process. For Rogers, the decision an individual (or other decision-making unit) makes to ultimately adopt or reject an innovation is the result of a five-stage process (Rogers, 2003). Rogers called this basic model for change the innovation-decision process. The five stages are viewed as ordered by time and the process flow is shown in Figure 2.

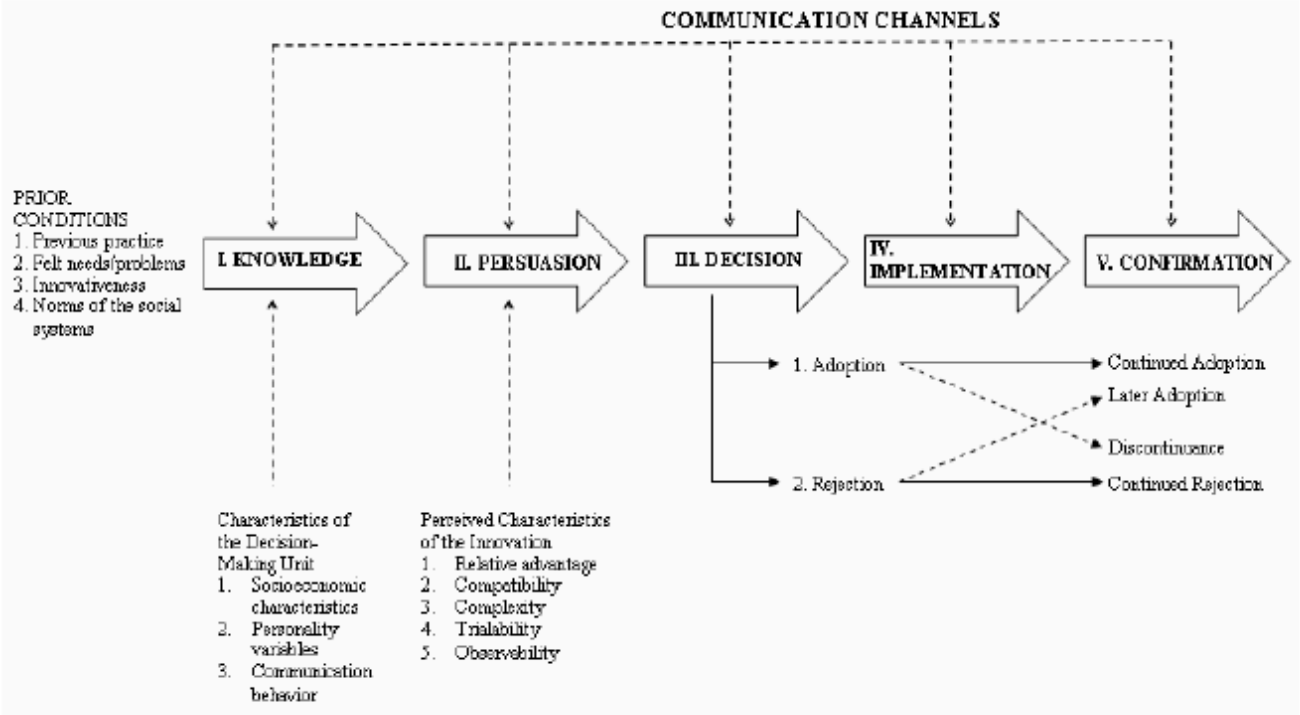

Figure 2. A Model of Five Stages in the Innovation-Decision Process (Source: Diffusion of Innovations, Fifth Edition by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.) Permission letter can be found in Appendix B.

The primary concern in early DOI research addressed adoption and diffusion at the level of the individual (farmers); however, Rogers includes a chapter, in his most recent addition of DOI (2003), on the diffusion of innovations by organizations. Rogers (2003) notes that the innovation-decision process in organizations is far more complex than the innovation-decision process in individuals. Educational technology innovations tend to be adopted at the enterprise-level by organizations. The organization does not always follow up with the implementation stage of the process (Rogers, 2003). It was Zaltman and colleagues (1973) who first designed studies specifying *implementation* as the dependent variable in contrast to studies prior to the early 70's research, which focused on adoption or non-adoption of an innovation. It is only after

publication of Innovations and Organizations (1973), that research on innovations centered on investigations of the implementation of a single innovation.

Research results from Rogers' benchmark study in 1957, along with thousands of subsequent studies (appearing at the rate of about 250 each year in a wide range of scholarly journals) in diffusion research, have resulted in a general framework of diffusion which has provided researchers with a theoretical approach to their investigations (Rogers, 2004). Rogers has spun off multiple sub-theories from the generalized theory of diffusion. One of Rogers' "micro" theories, which has been widely embraced by the IDT field, is the Theory of Perceived Attributes. This micro theory of diffusion has five attributes by which potential adopters judge the innovation: trialability, observability, relative advantage, complexity, and compatibility. These five attributes have been shown to account for up to 87 percent of a user's decision to implement an innovation. Instructional designers face the complex challenge of wrapping design strategies around an innovation, which was adopted at an enterprise-level while analyzing current learners and planning the implementation phase. Increasingly, the instructional designer turns "to diffusion theory in an effort to increase the adoption of instructional technologies" (Surry & Farquhar, 1997, p.1).

Traditionally, instructional designers have focused efforts on the systematic design and development of instructionally sound products (Gagne, Briggs, & Wager, 1988), but have not emphasized the importance of other issues in the learning environment (Ely, 1999a; Surry & Ensminger, 2002; Surry, Jackson, Porter, & Ensminger, 2006; Tessmer, 1990). Tessmer (1990) argued the importance of the environment analysis and proposed a standard methodology, which consisted of a questioning process: "Without an appropriate environment analysis, an

instructional design project may produce theoretically sound but practically unusable products" (p.56). The instructional designer uses the environmental analysis to gather information about the instructional environment and the support environment. Rogers' theories of diffusion provide a solid framework for instructional technologists as they design approaches to address optimal uptake of innovations.

The researcher and the practitioner turn to the DOI model's innovation-decision process (Rogers, 2003) when tasked with understanding and planning for the introduction of something new. Ely (1990a, 1999a, 1999b) was a prominent researcher in the field of educational technology who built his model of change on the sound theoretical underpinnings of Rogers' generalized diffusion model. Ely's (1999a) research focused on the implementation phase of the change process.

Models of change. Ely's protégé, James Ellsworth, pulled the vast amount of published literature on educational change into a manageable set of major perspectives which he called "models" of change (Ellsworth, 2000). In his book, Surviving Change: A Survey of Educational Change Models (2000), Ellsworth developed a synthesis model for change, referred to as the Change Communication Model.

Ellsworth's goal, in developing this model, was to provide a framework for a comprehensive strategy to guide the change process for instructional designers. Ellsworth's (2000) model for change communication offers the practitioner a guide "to illustrate how the tactics represented by the classical change models may be fused into a comprehensive, systemic strategy for the change process as a whole" (p. 26). The model is made up of seven components: Innovation, Environment, Change Agent, Change Process, Intended Adopter, Resistance, and System.

Using components of the Change Communication Model, Ellsworth created a Taxonomy of Change Models (2000) consisting of seven classical frameworks of change. Ellsworth selected the change models for his taxonomy based on decades of research and practice supporting the constructs and their extensive use in the field of IDT (Ellsworth, 2000). These seven change models are presented in Table 3.

Table 3

Ellsworth's (2000) Seven Classical Frameworks of Change

Name of Developer/s	**Name of Model**	**Classical Framework of Change Component**
Everett Rogers (1962)	Diffusion of Innovations	Innovation
Donald Ely (1990)	Conditions that Facilitate the Implementation of Educational Technology Innovations	Environment
Fullan & Stiegelbauer (1991)	The New Meaning of Education Change	Change Agent
Havelock & Zlotolow (1995)	The Change Agent's Guide	Change Process
Hall & Hord (1987)	Change in Schools, Facilitating the Process	Intended Adopter
Zaltman & Duncan (1977)	Strategies for Planned Change	Resistance
Reigeluth & Garfinkle (1994)	Systemic Change in Education	System

Environment is only one of the seven components Ellsworth (2000) noted as important to the process of change. Ellsworth selected Ely's (1990a) model as the most significant model of change in informing the environment component of the Change Communication Model. Additionally, Ellsworth (2000) argued that Ely's model of change is the "broadest and most far-

reaching of the classical change models" (p. 67) and was the first study to focus on organizational, structural, and motivational characteristics of the environment.

Ely's Model of Change

As an instructional designer, Ely's earliest research into change was situated in university libraries. Ely (1978) introduced three concepts of change: quick change, small change, and loose change. Change, which occurred in a quest for efficiency, is "quick change". Automation activities and computer-assisted instruction are examples of this type of change. Change, which resulted in smaller organizations or units, was grouped under "small change". Examples of small change would be when a technology which automates, results in fewer librarians needed in the organization. Loose change addressed emerging unknowns that *will* affect librarianship, but no one knows how at the time. An example of this would be open education resources (OER). As Ely emerged a leading theorist in the field of IDT and a change scholar, he abandoned these categories and moved toward more comprehensive constructs.

Ely (1990a) began to fully develop his conditions of change proposing seven conditions that facilitated the implementation of educational technology innovations. Ely's research was heavily influenced by Mayhew (1976) and Eraut's (1975) studies of the nature of innovation, change and reform in universities and the conditions, which serve as hindrances and constraints on the implementation of planned change. Mayhew (1976) was puzzled by the lack of critical impact on the lives of undergraduate students by available and educationally relevant innovations. He began the study with the assumption that "a greater understanding of how innovations and changes in education are attempted could be useful to produce greater and more sustained acceptance of educational, information, and communications resources in colleges and

educational gains" (p. 8). Eraut's (1975) research also focused on constraints on innovation as a process of planned change, rather than focusing the introduction of a new product or method.

Mayhew and Eraut's research revealed a pattern of conditions, which *hinder* change. Ely leveraged their investigations of these conditions in building his framework for conditions, which *facilitate* change for the implementation of educational technology innovations. Ely derived his earliest iteration of conditions of change from Mayhew and Eraut's studies in higher education from the perspective of conditions, which support change. Ely's (1978) presented the seven original conditions in the context of university libraries: (a) dissatisfaction with the present situation, (b) skills and knowledge, (c) commitment at all levels in the organization, (d) resources, (e) time, (f) rewards, and (g) leadership. The original seven conditions for creating change along with Ely's descriptions—which apply to innovations in general—can be found in Appendix C

In 1990, after decades of research spanning several continents and numerous countries, Donald Ely, published his research in an article titled "Conditions that Facilitate the Implementation of Educational Technology Innovations" (1990a). Ely spent the next eight years in the international phase of his study in order to validate the presence of the eight conditions in other countries in a variety of settings. During those eight years, Ely oversaw nine dissertations "using the conditions as a framework for studying implementation in various contexts" (Ely, 1999a). Ely's seven conditions of change, presented in his 1978 article, evolved into eight conditions which facilitate implementation of educational technology innovations based on these studies. These nuanced revisions, between 1990 and 1999, move toward a more generalizable set of guidelines (Appendix A). Ely (1990a) concluded this article with prophetic words of

warning that "…the decades to come might rewrite the conditions in light of the changing times in which we live" (p. 304).

Ely developed his eighth condition, participation, after almost 15 years of study. It is worthy of note that Dr. Ely was considering adding a ninth condition to his framework, trust, at the time of his death in September 2014 (personal communication Ensminger, May 2015). It is through relentless and rigorous scholarship that Ely's eight conditions have come to be considered an important and comprehensive model of change in the IDT field (Ellsworth, 2000).

Studies of Ely's conditions as a framework for investigating implementation. Funded by a Fulbright scholarship, Ely (1990b) conducted a status study of instructional technology in formal and non-formal sites in Indonesia, Chile, and Peru. Ely's study encompassed investigation of multiple components of the diffusion and innovation process. However, for purposes of the current literature review, results confirming the existence of the eight conditions in Ely's framework were the focus. Ely used a structured interview process in which qualitative data were collected from twenty-five or more leaders of instructional technology in each setting. The presence of the existing eight conditions and an exploration of other factors influencing implementation, were the focus of Ely's investigations.

The results of the study (1990b) showed that in spite of a lack of consensus on the definition of educational technology, most of the conditions, which facilitate adoption and implementation of educational technology, were present in all three countries. Dissatisfaction with the status quo, the need for knowledge and skills, the need for resources, the need for leadership, and a commitment to the innovation were ubiquitous.

> However, the other conditions were not as strong in some of the countries. The need for rewards or incentives was weak in Chile and Peru but strong in Indonesia. Participation in the implementation of educational technology was weak in Chile and Indonesia but

> strong in Peru. One could speculate on the reasons for the strengths and weaknesses of the conditions but this analysis is best saved for another paper (Ely, 1990b, p. 78).

A Fulbright funded status study, confirming existence of conditions in other cultures (1990b), and his 1999a paper suggested the generalizable nature of the conditions in a variety of settings. The nine dissertations, carried out under Ely's supervision, used his framework for studying implementation in various contexts in the United States (Bauder, 1993; Haryono, 1990; Jeffrey, 1993; Marovitz, 1994; Ravitz; Read, 1994; Riley, 1995; Stein, 1997). The focus of those studies was on assessing the presence of the eight conditions in settings *after* the innovations were in place. The questionnaires developed by the researchers, utilizing a quantitative approach, were specific to the innovation and were not designed to gather information at the level of the individual user. Also important is the fact that the instruments developed for the nine studies had not assessed the perceived importance of these conditions prior to or during implementation, nor compared the difference of importance of the eight conditions between groups (Ensminger, 2005).

Most important to the current study was the fact that only two of the nine studies, authored under Ely's supervision, employed a quantitative survey research method and conducted a factor analysis to look at the dimensionality of Ely's (1990a) eight conditions of change. Bauder (1993) and Ravitz's (1999) studies analyzed covariances among the eight conditions to discuss possible relationships between the conditions.

Bauder (1993) wanted to know which of Ely's (1990a) conditions best predicted the implementation of computers in the instructional process in a K-12 setting. In general, her study showed that all of Ely's conditions facilitate implementation of computers in the instructional process when present, and limit their implementation when absent. More specifically, Bauder found that the condition Dissatisfaction with Status Quo (DSS) was shown to be unrelated to

computer use, but strongly linked to Leadership. She felt there was confusion with dissatisfaction (or unhappiness) with current teaching methods and a dissatisfaction with change in general. Bauder did not operationalize DSS as it relates to usefulness or ease of use of the technology.

Bauder (1993) factor analyzed the results of 352 respondents to a 40-item questionnaire designed to assess K-12 teachers' perceptions of Ely's conditions within their schools regarding computer use (five indicator measures per each of Ely's eight conditions). Using a method known as Principal Axis Factor Analysis (similar to PCA and EFA) to conduct factor recovery, Bauder recovered two new factors in her study. She also found that her five indicators developed to measure the condition, Commitment, did not load on any factor. Bauder found similar results with her indicator measures leading her to the conclusion that Ely's eight conditions are difficult to measure. Bauder's results from the factor analysis suggested the need for possible refinement of Ely's eight conditions based on the complexity of the conditions and their strong interrelationships.

Ravitz's (1999) assessment of Ely's (1990a) eight conditions of change were part of a much larger national study of schools and internet-using teachers conducted by The University of California, Irvine & UCLA for the members of the National School Network in 1998. Ravitz was constrained by the need to limit the number of indicator measures per condition and the inability to formally pre-test the items. Ravitz's (1999) research and comprehensive analysis of the results suggested the relationship between Ely's (1990a) eight conditions were at times inconsistent with operationalized definitions.

> Some items that do not load together in factor analysis were combined based on the conceptualization of the condition being measured, i.e., based on face validity arguments alone. Ultimately, determination of the appropriateness of combining items was based on

> both empirical and logical analysis, including interpretations of Ely's framework and the conceptualization of the index being established (Ravitz, 1999, p. 79).

The results of Ravitz's factor analysis of items developed to measure Ely's conditions provided support for the eight conditions being categorized as three distinct factors or addressing three different dimensions of change. He found that Dissatisfaction with Status Quo emerged as a separate factor, showing the greatest independence from the other conditions. Knowledge & Skills and Participation loaded on a factor labeled as Expertise. The third factor was labeled Environment and included the remaining five conditions of Commitment, Incentives and Rewards, Resources, Time, and Leadership. Ravitz operationalized and analyzed Dissatisfaction with Status Quo in terms of the innovation's attributes.

Both Bauder (1993) and Ravitz's (1999) studies hinted at results with taxonomic implications for Ely's (1990a) framework. Neither Bauder nor Ravitz's studies set out to determine a more parsimonious measurement model for possible scale refinement. No confirmatory studies testing their exploratory factor structures studies have been published.

The lack of studies looking at Ely's (1990a) eight conditions prior to and during the implementation of a new technology, along with the lack of reliable and valid instruments to measure the constructs of interest, inspired Surry and Ensminger to begin their research on the development of an instrument designed to measure perceptions of individual users regarding the importance of Ely's eight conditions before and during implementation of an innovation. Additionally, Surry and Ensminger's objective was to examine any underlying relationships among Ely's eight conditions. The ultimate goal of Surry and Ensminger's research was to develop and validate an instrument, which could yield scores to assess the instructional environment and to design support structures to "increase the implementation of the instructional products" (Ensminger, 2005, p. 24).

Surry and Ensminger have compiled a body of research on conditions, which facilitate innovation implementation. The focus of early research using the eight conditions as a framework for studying implementation was on describing the conditions and perceptions of these conditions post implementation (Ensminger & Surry, 2002; Ensminger, 2001; Hj Nawawi, 2005; Surry & Ensminger, 2002; Surry & Ely, 2001; Surry, Ensminger, & Haab, 2005; Varden, 2002). In contrast to these earlier studies, Surry, Ensminger, and colleagues designed studies with "a proactive approach to assessing the importance of these conditions within an organization in order to facilitate change" (Ensminger, 2005, as cited in Ensminger, 2001). In shifting the research focus "from describing to assessing the importance of these conditions among potential users prior to implementation" (Ensminger, 2005, p. 5, as cited in Ensminger, 2001), the key questions for researchers became how can perceptions of these conditions be assessed for a specific organization and was there any prescriptive value in understanding these perceptions in an individual or an organization (Surry & Ensminger, 2008). Ely (1990a) emphasized that his eight conditions of change were not to be considered formulae or rules, but were to serve as guidelines and/or an inventory or checklist for planning for innovation implementation.

Surry and Ensminger's (2002) first attempt to measure the perceived importance of Ely's conditions prior to innovation implementation employed a questionnaire with scenario-based questions. The questions revolved around implementation of an online degree program and how important these eight conditions would be to the success of this type of program. The data gathered in the Surry and Ensminger study showed faculty valued all eight conditions as important to the implementation process. However, cumulative percentages for the ratings (a 5-point Likert scale) showed faculty considered Resources, Knowledge and Skills, and

Dissatisfaction with Status Quo as the most important of the eight conditions. Surry and Ensminger's early research provided better understanding "…of how one important set of stakeholders (i.e. faculty) view the importance of the eight conditions that facilitate implementation" (2002, p. 5). It was the results from this 2002 study that served as the impetus for the development of the Implementation Profile Inventory, first generation.

The structure and dimensionality of Ely's eight conditions which facilitate implementation of educational technologies are important theoretical issues which have received considerable attention in the complex, integrated arena of educational technology (Berman & McLaughlin, 1976; Berman, 1981; Burkman, 1987; Carlopio, 2003; Ellsworth, 1998; Ely, 1978; Eraut, 1975; Fullan, 1982; Gagne et al., 1988; Hall, Wallace, & Dossett, 1973; Hall & Hord, 1987, 2011; Rogers, 2003; Schon, 1967; Tessmer, 1990; Zaltman & Duncan, 1977). Ely's (1990a) eight conditions of change emerged as a comprehensive model grounded in classical change theory. The importance of developing instruments (tests and scales) for measuring user perceptions of conditions which support change, are crucial to understanding how conditions influence the user's decision to implement educational innovations (Bauder, 1993; Ensminger et al., 2004; Ravitz, 1999; Straub, 2009; Surry & Ensminger, 2004; Surry, Grubb, Ensminger, & Ouimette, 2009).

Many studies have attempted to assess the importance of Ely's (1990a) eight conditions to the successful implementation of innovations in multiple settings (Brown, 2008; Ellsworth, 1998; Haryono, 1990; Hj Nawawi, 2005; Jeffery, 1993; Marovitz, 1994; Murphy, 2015; Ravitz, 1999; Read, 1994; Riley, 1995; Stein, 1997). However, those studies have been exploratory studies or replications using exploratory techniques. Few researchers have devoted serious attention to the quantitative *measurement* of Ely's eight conditions of change and their

underlying factor structure (Bauder, 1993; Brown, 2008; Ensminger et al., 2004; Ensminger, 2005; Ravitz, 1999). None of those studies have used confirmatory factor analysis to complete the research cycle needed for developing a standardized instrument for measuring perceptions of importance of Ely's eight conditions (Doll et al., 1994).

Implementation Profile Inventory Instrument (IPI)

With a continued focus on the implementation phase of the ADDIE model (Surry & Ely, 2001), Surry and Ensminger (2004) took the first step in developing an instrument that would determine the importance of change conditions. The IPI instrument (also referred to as a scale, survey, or questionnaire) was developed by Surry and Ensminger (2004). The first edition of the IPI was designed to determine the relative importance of Ely's (1990a) eight conditions and measure the "underlying relationships between these conditions" (Ensminger et al., 2004, p. 65). As noted earlier, it was Surry and Ensminger's desire to explore the potential prescriptive value of Ely's framework for providing results that could assist organizations with planning for implementation of innovations, which provided purpose and intent for instrument development.

Development of the IPI, first generation. Grounded in Ely's (1990a) theoretical framework for change, Surry and Ensminger (2004) created a blueprint for the development of the IPI. Surry and Ensminger wanted to look at all eight of Ely's conditions as they related to a technology process and a technology product. This resulted in two forms of the IPI (a process form and a product form). The researchers then proceeded to develop a measurement scale by generating items (indicator measures) intended to measure the perceived importance of Ely's eight conditions to a user's decision to implement a new technology process or product. Fifty-six comparisons were developed, each comparison consisting of statements for two conditions.

Based on feedback from a group of researchers with substantive knowledge in the field, twenty-one of the statements were reworded and all statements remained (Ensminger, et al., 2004). A forced-choice comparison format was chosen to provide a score representing the relative importance of the conditions to the individual. The inventory was then translated to a self-report, self-scoring online questionnaire in two forms. The online questionnaires were beta tested for bugs and found to be error free (Ensminger et al., 2004).

Factor Structure of the IPI-I. The IPI technology form was pilot tested to determine any "underlying relationships between Ely's eight conditions" (Ensminger et al., 2004). The newly developed IPI was delivered electronically via email to several listservs related to the field of instructional design. Data were collected from 179 participants across six work settings (K-12, Higher Education, Military, Business, Military, and self employed). The statistical software package SPSS was used for two data analysis methods: (a) descriptive statistics were used to provide a summary of the data for the study sample, and (b) factor analysis was used to determine underlying relationships between the conditions.

The primary analytic procedures used in the pilot study (Ensminger et al., 2004) were a collection of data on the profiles, comparison of the eight condition profile scores across occupations, and an exploratory factor analysis (EFA) of Ely's (1990a) eight conditions. Descriptive statistics were presented showing the rank order of importance of each condition for the various groups. However, no statistical analysis was conducted on the different occupational groups due to the discrepancy of the group sizes. A principal component analysis (PCA) was conducted on the dataset in order to explore the underlying factor structure of Ely's (1990a) eight conditions. PCA is a variable reduction technique similar to EFA.

The purpose of using PCA or EFA as a technique at this stage in the development of an instrument is to determine the number and nature of the factors (also referred to as latent variables, underlying constructs, or dimensions) of a set of indicator measures (Brown, 2015) thus revealing the dimensionality of the instrument. EFA is typically utilized in the initial stages of instrument development when the underlying structure of an instrument is unknown. As a result of the EFA from Ensminger et al.'s (2004) research, highly correlated variables were grouped together to form a separate, higher-level factor structure. Ensminger and colleagues (2004) comprehensively conceptualized and named these four higher-level factors that emerged through further research, statistical information, and theory.

The main finding of the study (Ensminger et al., 2004) resulted from the factor analysis, which showed an underlying relationship linking four higher-level factors with Ely's (1990a) eight conditions revealing the number and nature of the constructs assessed by the IPI. The resulting correlations are interpreted as correlation coefficients with a range from -1.00 to +1.00, indicating negative and positive correlations respectively. These communalities describe the amount of variability explained by the latent variables.

The proposed factor structure calibrated from the study sample (Ensminger et al., 2004), conjectured Ely's (1990a) eight conditions to load on the latent dimensions of Managed Change, Performance Efficacy, External Rewards, and Resources. There are no threshold values or rules guiding scores for factor loadings (Comrey & Lee, 1992). The cut off values used to determine primary factor loadings are arbitrary and decided by the researcher (DiStefano, Zhu, & Mindrila, 2009). Ensminger and colleagues (2004) "decided that for a condition to load on a factor, it must have a minimum absolute value of .45 and must not have loaded on another factor at an absolute value of .45 or greater" (p. 68). Table 4 shows Ely's eight conditions reduced to four factors,

accounting for 73.3% of the variance. It noteworthy that Ensminger et al. (2004) chose the arbitrary cut off of ≥ 0.45 in determining which conditions loaded on the higher level constructs. For purposes of testing the hypothesized four-factor structure (Ensminger et al., 2004) as a comprehensive solution representing the underlying factor structure of the IPI-II, the current study chose a threshold of ≥ 0.50 (Stevens, 2012) as the cut off for a condition to load on one of the four factors. This decision along with Ely's (1999) research showing Dissatisfaction with Status Quo to be most consistently linked to the condition Leadership in his studies informed the three plausible alternative factor structure model specifications tested in the current study.

Table 4

Ely's Eight Conditions' Primary Factor Loadings (Ensminger, et al., 2004)

Conditions	Managed Change	Performance Efficacy	Extrinsic Rewards	Resources
Dissatisfaction with Status Quo	**-.628**	-.172	.055	-.496
Skills & Knowledge	-.426	**.528**	.434	.060
Resources	-.136	-.023	.079	**.901**
Time	-.082	**.774**	.028	.066
Participation	-.081	**.774**	.133	.046
Rewards	-.201	.089	**-.945**	-.056
Commitment	**.800**	-.237	.127	-.217
Leadership	**.858**	.029	.103	-.048

Note: Primary factor loadings are bolded.
Ensminger et al. (2004) decided the cut off score to show a condition loaded on a factor was .45 and that there must be no double-loading (Ensminger, 2005). Dissatisfaction with Status Quo loads above .45 on two factors.

Understanding that a large number of multi-factor models could exist for showing good-fitting solutions (Brown, 2015), the developers focused on an orthogonal rotation method to

improve the interpretability of the results and assure the goodness-of-fit of the hypothesized four-factor structure (Ensminger et al., 2004). Three key questions emerged based on the results of the study which formed the basis for future research in this area (Ensminger et al., 2004): (a) Are the factors discovered in this study consistent? (b) Do these factors hold true for process innovations? and, (c) Do the profile scores generated from the implementation inventory reflect the conditions that people think are important when implementing a new technology?

Ensminger's study using the IPI, first generation. Ensminger (2005) employed both forms of the IPI in his dissertation, integrating the results of the 2003 pilot study (Ensminger et al., 2004) into his methodology. Ensminger incorporated the fundamental psychometric issues associated with the IPI of dimensionality (internal structure and consistency), content validity, and test-retest reliability evidence calibrated from the sample in the Ensminger, Surry, Porter, Wright (2004) study. In order to address the research questions guiding his study, Ensminger's (2005) quantitative data analysis consisted of calculating the mean, mode, median, standard deviation, and range of Ely's (1990a) eight conditions for three occupational groups (K-12, Higher Education, Business/Industry) with the IPI process and product samples. Additionally, Ensminger (2005) presented sixteen one-way Analyses of Variance (ANOVA) using occupational group as the single factor. Also noteworthy, is the fact that Ensminger did not address the question from the initial study (Ensminger et al., 2004) concerning the consistency of the underlying factor structure of the IPI, referencing potential limitations of the interpretability of the emergent four-factor structure due to potential weaknesses posed by the ipsative data yielded by the forced-choice format of the IPI-I (Ensminger, 2005).

The focus of Ensminger's (2005) study using the IPI-I was on the instrument's ability to measure differences among individual and group perceptions of the importance of Ely's (1990a)

eight conditions for both the technology and the process forms of the IPI-I. Ensminger noted that in spite of the IPI-I being a new instrument, it had undergone more psychometric evaluation than any previous instrument used to assess Ely's eight conditions and his study provided additional evidence to support its reliability and validity (Ensminger, 2005). Results from Ensminger's (2005) study supported the IPI-I as a useful research instrument and a helpful tool for the practitioner when measuring perceptions of the importance of Ely's eight conditions.

To address weaknesses in the original measure, the revision process of the IPI began (D. Ensminger, personal communication May 12, 2015). Ensminger (2005) provided details on how the original IPI should be re-designed based on quantitative and qualitative data analysis. In order to accommodate factor analysis, future development of the IPI should involve a Likert scale (polytomous items) that would result in normative data. The forced-choice format of the original items (dichotomous items) of the IPI resulted in ipsative data. There is considerable controversy concerning whether ipsative data can be factor analyzed and produce valid results (Redli, 2015). However, given the history of psychometric properties of ipsative measures, Ensminger felt the controversy presented a potential weakness in the measure and warranted a significant revision of the scale. Qualitatively, the majority of the comments were also associated with the forced-choice format and the resulting redundancy and length of the questionnaires.

Implementation Profile Inventory, Second Edition (IPI-II)

In response to the recommendations, which emerged from Ensminger's (2005) study, Surry and Ensminger began revising the IPI. Their efforts resulted in the development of an instrument with one form to measure perceptions of Ely's (1990) eight conditions for change, scaled to provide normative measures which can be interpreted inter-individually. Like the original IPI,

the revised instrument is theoretically grounded in constructs explicitly defined in Ely's classical framework for change. Surry and Ensminger began work on the modification of the IPI-I by removing redundancy present in the forced-choice design of the items. The developers did not want to compromise reliability by greatly reducing the number of indicator measures. For seven of Ely's 91990a) eight conditions, they created one indicator to be reverse coded, one indicator to serve as a validation question to be used as a possible member check along with four additional measures for accuracy. For the condition, Resources, they added a seventh indicator for good measure. This resulted in forty-nine stand-alone statements to be used as measures of Ely's eight conditions of change. The developers conducted a solid content validity check and one test-retest study (D. Ensminger, personal communication, September, 22, 2015).

To enhance this revision process, the developers requested feedback about the modifications from experts in the IDT field and conducted a small (N=12) Test-Retest (D. Ensminger, personal communication May 14, 2015). Content validity is indicative of whether a scale measures the theorized construct/s that it intends to measure. Test-retest reliability denotes the measure's ability to provide approximately the same measure of test performance over time and is the most common form of reliability (Pedhazur & Schmelkin, 2013). Test-retest reliability was determined based on a two-week time frame. The values ranged from adequate to high (i.e., r = .7 and higher). The values for the conditions Dissatisfaction with Status Quo, Participation, and Skill and Knowledge have the lowest reliability (i.e., less than r = .7). Reliability values for the conditions Leadership and Time were calculated at .94 and .92 respectively. Table 5 shows the Test-Retest reliability coefficients for the IPI-II conducted by Surry and Ensminger (D. Ensminger, personal communication May 12, 2015).

Table 5

IPI-II TEST-RETEST Reliability: Coefficient of Stability

Ely's Condition	**r value**
Dissatisfaction with Status Quo	.579
Leadership	.942
Participation	.533
Resources	.762
Rewards	.856
Skill and Knowledge	.448
Time	.920
Commitment	.787

Notes: N=12, Two-week interval
Source: (D. Ensminger, personal communication May 12, 2015)

Surry and Ensminger called the revised instrument the IPI-II (n.d.). Since the IPI-II was developed with an a priori hypothesis of the relationship among the items, Ely's (1990a) eight conditions, and the four underlying factors, the current study utilized CFA as the primary analytic method for evaluating the instrument's multidimensionalilty with correlated dimensions, along with additional psychometric properties related to reliability and validity evidence. Ensminger's (2005) study reported on the statistical methods used to gather validity evidence for the IPI and Ensminger (Ensminger, personal communication, May 12, 2015) reports content and face validity of the IPI-II "remain the same" as the IPI-I. According to Surry and Ensminger (personal communication May 2015), no reliability or validity work on the new format of the instrument has been published, nor has any research been conducted using the revised instrument. The hypothesized dimensional structure of the IPI-II is shown in Table 6.

Table 6

Dimensional Structure of the IPI-II

Ely's (1990) Condition	**Test Item**	**Four-Factor Structure (Ensminger et al., 2004)**
Dissatisfaction with Status Quo	38, 35, 22, 29, 31, 39	Managed Change
Commitment	5, 26, 21, 6, 36, 15	
Leadership	45, 23, 20, 46, 28, 11	
Knowledge and Skills	47, 25, 30, 8, 2, 37	
Time	43, 9, 48, 27, 13, 19	Performance Efficacy
Participation	12, 33, 3, 1, 14, 40	
Resources	34, 49, 4, 42, 10, 41, 18	Resources
Rewards or Incentives	7, 24, 16, 44, 32, 17	Rewards

Psychometric Properties and Confirmatory Factor Analysis

There is no consensus on criteria for what constitutes adequate properties in the field of psychometrics (Mokkink et al., 2009). However, Messick (1989) argues, that "basic sources of validity evidence are by no means unlimited" (p. 3) for identifying sources of evidence germane to the validation of the interpretation and use of the scores of an instrument. The internal structure of an instrument is an important piece of validity evidence in instrument development—essentially answering the question of whether a set of items about conditions that support a positive climate for change have a unidimensional or multidimensional underlying latent factor structure (DeVellis, 1991).

From a psychometric perspective, confirmatory factor analysis (CFA) is seen as a crucial step in the validation of an assessment tool used to identify relationships among test items and a set of latent variables (also known as factors). Additional sources of validity evidence useful in the cycle of establishing psychometric properties of an instrument are derived from an item analysis. Item analysis is important in determining the quality of the items and in determining properties of the instrument as a whole. There are two primary item quality indicators: difficulty (also known as item mean or average score) and discrimination. Item difficulty, in terms of a psychological measure (i.e. perceptions) in which there is no correct answer, translates to item endorsability. And, item discrimination is an indicator of the strength of the relationship between the item and the instrument as a whole (Osterlind, 2006). Analyzing difficulty and discrimination for test items can be used to inform overall reliability of the measure.

In addition to theory driven item development and exploratory research, factor analyses can provide solid interpretable descriptive statistics for examining psychometric properties of instruments. Exploratory factor analysis (EFA) is criticized for being entirely descriptive, too open to interpretation, and unusable for hypothesis testing (Giles, 2002). CFA has recently emerged as a popular method for examining fundamental psychometric issues that *can* be used to describe data, test hypotheses and provide inferential statistics (Brown, 2015; Furr & Bacharach, 2014; Giles, 2002).

CFA is alternately considered a type of factor analysis or a variety of structural equation modeling (SEM) and "depending on the types of variables and the complexity of the design…you will note that different researchers use different terms to describe what amounts to the same basic technique" (Giles, 2002, p. 82). The terms latent variable, latent trait, factor, and construct are used interchangeably. Path analysis is considered an extension of multiple

regression and is explained by a path diagram. An input path diagram represents the hypothesized measurement model or solution and an output path diagram represents the results of the analysis, or the actual findings of the CFA study (Furr & Bacharach, 2014). Factor analysis procedures create correlations or factor loadings between latent and observable variables (Brown, 2015). Correlations resulting from factor analysis are interpreted as correlation coefficients with a range of -1.00 to +1.00 when presented as standardized parameter estimates.

One of the primary functions of CFA is the psychometric evaluation of a measure—a necessary, yet time consuming part of instrument development. In addressing fundamental psychometric qualities, CFA provides evidence of the nature and strength of dimensionality, reliability, and validity of an instrument—thus, allowing the discussion of their effects on the ability to interpret results in terms of specific constructs (Furr, 2011; Harrington, 2009). The stronger the validity, the more comfortable and confident the researcher and practitioner can feel going forward with interpreting results for decision-making purposes in a given situation.

The current study addresses the dearth of instruments developed to assess the eight conditions, which have undergone psychometric evaluation (Ensminger, 2005). No existing instruments developed to measure Ely's (1990a) conditions, which influence implementation of educational technologies, were found that had been subjected to the methodological rigor of a confirmatory factor analysis.

Dimensionality, Reliability, and Validity. The concept of dimensionality is key to the development, evaluation, and use of an instrument (Furr & Bacharach, 2014). The number of dimensions of an instrument indicates what the instrument measures and if it measures one construct or multiple constructs. An instrument's dimensionality or internal structure is also a reflection of an instrument's internal consistency. The internal structure of an instrument is an

important piece of validity evidence in instrument development. Validity is important to the "appropriateness, meaningfulness, and usefulness" (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014, p.11) of instrument scores in order to understand and support the properties of an instrument (Osterlind, 2006).

CFA is a flexible method for examining reliability, capable of going beyond the widely used coefficient alpha method, when the assumption is multidimensionality in a sample of test items and when the goal is higher-order factor analysis (Furr & Bacharach, 2014). When using CFA, reliability can be estimated from a sample of respondents by indicating whether the factor structure of the IPI-II fits well. When the study design requires it and the hypothesized model proves to be a poor fit, a second step in the CFA can be used to identify revisions to the model and propose plausible alternative factor structures as measurement models.

Summary

Studies suggest that a successful implementation strategy is more important to achieving desired outcomes than the design of the technology product or process. Researchers in the IDT field have come to recognize the importance of the implementation phase of the ADDIE model. There are multiple models of change, which address important components of a comprehensive change strategy. Rogers' (2003) innovation-decision process is one of the most diverse and widely accepted of the change theories and figured prominently in Donald Ely's comprehensive model of change.

The literature review began with an in-depth discussion regarding the theoretical foundations of the IPI-II. An examination of the literature related to Ely's (1990a) model of change indicated a salient but small category of studies using exploratory factor analysis (EFA) to suggest Ely's

conditions may account for key characteristics facilitating innovation implementation. Bauder's (1993) factor analysis of an instrument designed to measure perceptions of Ely's eight conditions in computer using teachers resulted in nine distinct factors. Ravitz's (1999) factor analysis of a set of indicator measures of Ely's eight conditions resulted in three separate factors. Most noteworthy for the current study was the emergence of Dissatisfaction with Status Quo as a distinct factor in both studies.

Previous studies by Ensminger, Surry, Porter, & Wright (Ensminger, 2004) employing the IPI, yielded a four-factor structure termed Managed Change, Performance Efficacy, Resources, and External Rewards. Dissatisfaction with Status Quo was not considered to load significantly on any of the higher-level factors emerging from the study. Surry and Ensminger (2004; 2004; 2005; 2008) developed the IPI, which has undergone more psychometric evaluation than any existing instrument used to assess Ely's eight conditions of change.

As a result of evaluating the psychometric properties of the IPI, a revision process was undertaken by Surry and Ensminger (n.d.) to generate a second edition of the IPI. It is critical to development of the IPI-II, that underlying relationships among constructs, purported to be measured by the IPI-II, were examined by collecting new validity and reliability evidence for the revised instrument (Doll et al., 1994). The focus of the current study was to provide reliability and validity evidence to substantiate the IPI-II's use as a measure of a user's perceptions of Ely's eight conditions of change and determine if the hypothesized four-factor structure underlying Ely's conditions is consistent (Ensminger et al., 2004) in a study comprised of 252 responses from a higher education setting.

Chapter Three

Methodology

This chapter presents the research study design used to develop and examine the reliability and validity evidence resulting from a one-time administration of the IPI-II within a population of university faculty and staff. The Implementation Profile Inventory, second generation (IPI-II), is an instrument developed by Surry and Ensminger (n.d.) to measure an individual's perceptions of the importance of Ely's (1990a) eight conditions of change when implementing an educational technology innovation. Permission to use the instrument was requested from Surry and Ensminger and granted in May 2015 (D. Ensminger, personal communication May 12, 2015). In each of the 49 items of the IPI-II, statements were unchanged as presented by Surry and Ensminger. Confirmatory factor analysis (CFA) was the primary statistical procedure conducted on three plausible alternative factor structure models for the IPI-II based on Surry and Ensminger's previous theoretical and empirical work (2004; 2005).

The current study marked the first known attempt to develop validity and reliability evidence for the IPI-II, a revised instrument.

Research Rationale, Significance, and Questions

The current study was designed to address a gap in the research on the development of the Implementation Profile Inventory—specifically, the lack of any confirmatory studies regarding the consistency of the underlying factor structure of the measure and lack of any published literature on the psychometric properties of the revised measure (IPI-II). Therefore, a CFA of the IPI-II responses was a critical step in providing sources of evidence germane to the validation of the interpretation and use of the scores from the IPI-II (Cole, 1987). The research objective of the current study was to provide reliability and validity evidence to substantiate the IPI-II's use

as a measure of a user's perceptions of Ely's (1990a) eight conditions of change. An investigation of the psychometric information obtained by conducting CFA allowed an examination of factor structure assumptions concerning the dimensionality of the IPI-II, an instrument designed to measure perceptions of the importance of Ely's (1990a) eight conditions of change.

When constructs are well grounded in strong theory, CFA can be employed to examine measurement model assumptions and interpret the resulting higher-level factor structures (Brown, 2015; Furr & Bacharach, 2014; Giles, 2013; Pett, Lackey, & Sullivan, 2003). In the current study, CFA was used to test whether the 49 observable measures (questionnaire items) of Ely's eight conditions are consistent with what researchers in the IDT field understand to be the nature of these constructs (Brown, 2015; Byrne, 2012; Furr & Bacharach, 2014; Jöreskog & Sörbom, 1989; Pedhazur & Schmelkin, 2013; Boomsma, ten Holt, & vanDuijn, 2010).

One of the goals of the original study (Ensminger et al., 2004) was to evaluate the dimensionality of the items in the IPI by "uncovering the smallest number of interpretable factors needed to explain the correlations among them" (Brown, 2015, p. 18). Using EFA, to look for patterns of relationships between the items and the latent variables, Ensminger and colleagues discovered four factors. These four factors were believed to account for the dimensions of change that Ely's (1990a) eight conditions addressed. The method of looking for a pattern with no prior assumptions of correlations represents the key difference between EFA and CFA. The typical application of CFA is to test the instrument dimensionality (factor structure) that emerged based on the results of an EFA.

In light of the factor structure hypothesized to underlie Ely's eight conditions from previous theoretical and empirical work, it was preferable to begin the analysis in the current study as

close as possible to the confirmatory end of the research cycle for developing a standardized instrument (Doll et al., 1994; Gerbing & Hamilton, 1996). Factor analysis is commonly described as a group of methods used to examine how underlying constructs influence the responses on a number of measured items. Factor analyses are performed by determining the pattern of covariance between the observable measures or between lower level and higher-level factor structures. Observable measures or constructs that are highly correlated are likely influenced by the same factors, while those that are uncorrelated are likely influenced by different factors (Brown, 2015, Furr & Bacharach, 2014; Giles, 2002). Results of a factor analysis reveal the dimensionality of the number of different and distinct latent traits the instrument measures. This information allows the researcher to go forward with the information that the instrument is uni-dimensional (measures one latent trait) or multi-dimensional (measure multiple latent traits correlated or uncorrelated).

Factor analysis is considered essential to researcher planning as regards use of an existing measure for which there is no published information regarding the internal structure (Pedhazur & Schmelkin, 2013). Factor analysis can be exploratory or confirmatory in nature. At the beginning of the research cycle for developing a standardized instrument for measuring latent variables, exploratory factor analysis (EFA) is appropriate for the development of hypothesized measurement models (Doll et al., 1994). CFA is helpful in completing the research cycle for developing a standardized instrument by testing the hypothesized measurement model/s with an independent dataset.

The key question of the current study was: What are the psychometric properties of the Implementation Profile Inventory II, a revised measure of Ely's conditions of change? In order

to answer the key question, three sub questions were used to guide the development and examination of reliability and validity evidence:

RQ1a: What psychometric information can be obtained from an analysis in which the four-factors hypothesized to underlie Ely's eight conditions were measured using 49 questionnaire items?

RQ1b: What psychometric information can be obtained from an analysis in which Ely's eight conditions were measured using 49 questionnaire items?

RQ1c: What psychometric information can be obtained from an analysis in which the four higher level factors and Ely's eight conditions were simultaneously measured using 49 questionnaire items?

To determine what psychometric properties are associated with the IPI-II instrument, confirmatory factor analysis was the primary procedure used to examine the data. Goodness-of-fit statistics were looked at in examining the adequacy of the hypothesized four-factor structure, in addition to parameter estimates from each alternative factor structure. Fit indices and parameter estimates are critical to determining the true dimensionality of the IPI-II (Furr & Bacharach, 2014).

Parameter estimates obtained in the analysis of the alternative factor structure models were carefully examined in assessing model fit. Additionally, parameter estimates were used to evaluate the IPI-II's specific psychometric qualities of reliability and validity. Factor loadings of the items on Ely's (1990a) conditions and the higher order factors are estimates of the validity of the items (Doll et al., 1994; Furr & Bacharach, 2014). Additionally, CFA was used to estimate the reliability of the items, factors, and the overall instrument by reporting the degree to which

the responses to the items were determined by the latent variable (factor) measured by that item (Furr & Bacharach, 2014).

Facets of the Four-factor Structure Model

Based on prior evidence and theory, a four-factor structure was hypothesized by Ensminger, et al. (2004) in which the conditions of Dissatisfaction with Status Quo, Commitment, and Leadership loaded onto the latent variable of Managed Change, in which the conditions Skills and Knowledge, Participation, and Time loaded on Performance Efficacy, in addition to the latent variables Resources and External Rewards. The hypothesized four-factor structure contains constructs, which have origins in Ely's (1990a) theory of change model. The constructs of Managed Change, Performance Efficacy, External Rewards, and Resources are grounded in the classical theories of change, which most influenced Ely's comprehensive model of change. Ensminger et al. (2004) labeled and described each of the factors.

Figure 3 presents the theoretical model of the hypothesized four-factor structure, which has been reported in the literature (Ensminger et al., 2004). A description of each of the four factors is presented in Table 7.

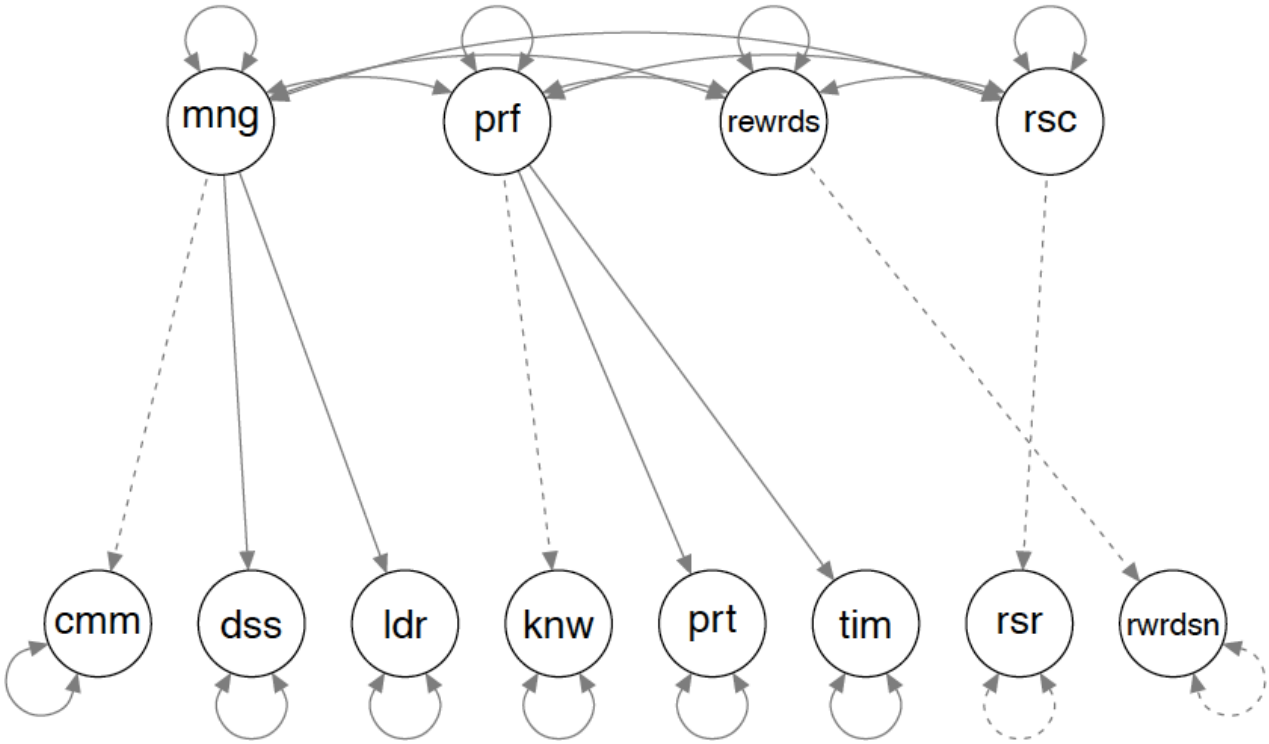

Figure 3. The hypothesized four-factor structure (Ensminger et al., 2004). Input data (factor loadings or path weights) for the path diagram are presented in Table 4 in Chapter Two. Diagram abbreviations include: mng = managed change, prf = performance efficacy, rewrds = external rewards, rsc = resources, cmm = commitment, dss = dissatisfaction with status quo, ldr = leadership, knw = skills and knowledge, prt = participation, tim = time, rwrdsn = rewards and incentives.

Table 7

Description of Each Factor in the Hypothesized Four-factor Structure (Ensminger, et al., 2004; Ensminger, 2005)

Factor (Ensminger et al., 2004)	Description	Ely's (1990) Condition
Managed Change (mng)	Individuals who endorse this factor value upper level management's active role in the change process. They expect direct communication from managers in an organization about the need for the change and expect to see these managers use the new technology and support their use of the new technology.	*Dissatisfaction with Status Quo (dss), Commitment (cmm), Leadership (ldr)
Performance Efficacy (prf)	Individuals who endorse this factor believe they possess the skills or can acquire the skills to use the new technology and do not feel it necessary to be included in the decision to change at the organizational level.	Skills and Knowledge (knw), participation (prt), Time (tim)
External Rewards (rewrds)	Individuals who endorse this factor believe that incentives and rewards should exist in some form. External rewards attached to the implementation of a new technology are important in their decision to implement. Ensminger et al., (2004) interpreted this factor by suggesting it was individuals who scored low who were more likely to implement a new technology if they knew they would be rewarded.	Rewards or Incentives (rwrdsn)
Resources (rsc)	Individuals who endorse this factor value the availability of hardware, software, faculty and staff development, and personnel to support their use of the new technology.	Resources (rsr)

Note: *Ensminger et al. (2004) did not consider the condition DSS to load significantly on any factor and does not address DSS in relation to the hypothesized four-factor structure. The current study used a threshold value of ≥ 0.50 as representative of significance and specifies DSS to load significantly on only one factor, Managed Change.

Specifications for Alternative Factor Structure Models

The prototypic use of CFA focuses on evaluating the acceptability of a hypothesized measurement model by testing the hypothesized structure in an independent observed dataset (Hoyle, 2000). Brown (2015) recommends the results of an initial EFA be interpreted cautiously and cross-validated with an independent data set. In order to answer the key research question, the current study specified and fitted three plausible alternative factor structure models by which to validate and verify the reasonableness of Ensminger et al. (2004) hypothesized four-factor structure. The three alternative factor structures tested were developed to be consistent with Ely's (1990a) *eight* conditions, Ensminger et al's (2004) *four* factors, and Surry and Ensminger's (n.d.) *forty-nine* items. The alternative factor structure models for the current study reference a set of indicators (items) that were constrained to load on the hypothesized four-factor structure (Ensminger et al., 2004) and/or Ely's (1990a) eight conditions with no double-loading indicators (Brown, 2015).

How to interpret a path diagram. Path diagrams are useful to describe and interpret CFA and structural equation models. They function in a similar fashion to flowcharts. The relationships between factors (latent variables) and indicators (observable measures or items) are interpreted through a diagram with single or double-headed arrows (Brown, 2015). Arrows are used to indicate the direction of relationships between variables. The dashed lines indicate which item was used as a marker indicator for reporting unstandardized parameter estimates (unstandardized parameter estimates are not reported in the current study). The curved lines with double arrows represent undirected relationships. Undirected relationships can represent variance (the line curves back from a variable to itself) or covariance (line curves from one variable to another).

To use a path diagram to discuss how data are generated, the direction of the arrows interpret how the latent trait influences a responses/responses (e.g., if a respondent perceives the factor "managed change" as important to the decision to implement of a new technology, they are more likely to endorse—score the item 5, 6, or 7—than a respondent who does not perceive the factor as important). The model path diagrams efficiently describe the theoretical structure of the measure (Brown, 2015; Giles, 2002; Harrington, 2009).

Models contain both observable measures and latent variables (Brown, 2015). The observable measures or indicators of the IPI-II are the 49 questionnaire items. These items serve as actual measurements (scores) while the latent variables (Ely's eight conditions and Ensminger et al.'s higher-level factor structure) represent the underlying constructs of what the IPI-II purports to measure. The latent variables found in the hypothesized four-factor structure (Ensminger et al., 2004) do not possess a unit of measurement; thus, a required step in CFA is to determine a unit of measurement (Harrington, 2009).

The lavaan package was used to determine the best estimates for the model parameters using the maximum likelihood (ML) method. The lavaan package is a commercial-quality, free open-source R package for latent variable modeling (Rosseel, 2012). The lavaan package estimated parameters and updated iteratively to best match the data; thus, finding the estimates that have the highest likelihood of having generated the observed data. When this maximum likelihood was reached, data were reported to have "converged normally" and the number of iterations required to reach normality was generated in a report.

The lavaan package also reported estimated factor loadings and the variance standardized factor loadings. The lavaan package computed estimated factor loadings by selecting the first indicator of the model specification and fixing it to 1.0 (Rosseel, 2012) resulting in

unstandardized parameter estimates. The method for selecting which item serves as the marker for each of the latent variables is based on the assumption that all items in the questionnaire are tau-equivalent (Brown, 2015; Hoyle, 2000).

Variance standardized factor loadings were generated when the items and the factors were scaled to have a variance equal to 1. Resulting values are exactly the same, just scaled differently. The current study used the standardized factor loadings for reporting purposes as these values are most often reported as such in CFA studies and the original IPI studies reported standardized factor loadings. Standardized factor loading values range from -1.0 to 1.0.

Justification for the specifications of the alternative factor structure models in the current study was grounded in prior exploratory research (Ensminger et al., 2004) based on Ely's (1990a) conceptual framework for conditions that influence the implementation of educational technologies and the four factors conceptualized and named by Ensminger et al. (2004). Alternative models for CFA allow the comparison between two or more models of the same constructs. The results of multiple models of the same construct/s can be used to (Hoyle, 2000; Marsh & Bailey, 1991):

- Address competing theoretical accounts of a construct or constructs;
- Look for over or under identified models;
- Seek a more parsimonious account of the data;
- Focus on the relationships among the factors; and
- Provide statistical support for modifications to a flawed factor structure model.

Model A (4 factors⇔49 items). Model A, shown in Figure 4, was specified to answer RQ1a. The lavaan package R syntax (Rosseel, 2012) was used to indicate the IPI-II's 49 items (observable measures) and the four factors (Ensminger et al., 2004) they were constrained to load

on: Managed Change (mnC), Performance Efficacy (prE), Resources (rsr), and External Rewards (rwr). The dataset containing the 252 responses was used to fit Model A. The eighteen items measuring Ely's (1990a) conditions Commitment, Leadership, and Dissatisfaction with Status Quo were restricted to loading on the factor Managed Change. The eighteen items measuring Ely's conditions Skills and Knowledge, Time, and Participation were restricted to loading on the factor Performance Efficacy (prE). The seven items measuring Ely's condition Resources, loaded on a unique factor Resources (rsr). Lastly, the six items measuring Incentives and Rewards were constrained to load on their own factor External Rewards (rwr).

Model A is visualized in Figure 4. In Model A, the Surry and Ensminger's 49 items were constrained to load on the four higher level factors hypothesized by Ensminger et al (2004) to represent the underlying factor structure of Ely's eight conditions. CFA is appropriate to test this hypothesized relationship since there is one layer of latent variables. Model A standard factor loadings are presented in Table D1 located in Appendix D.

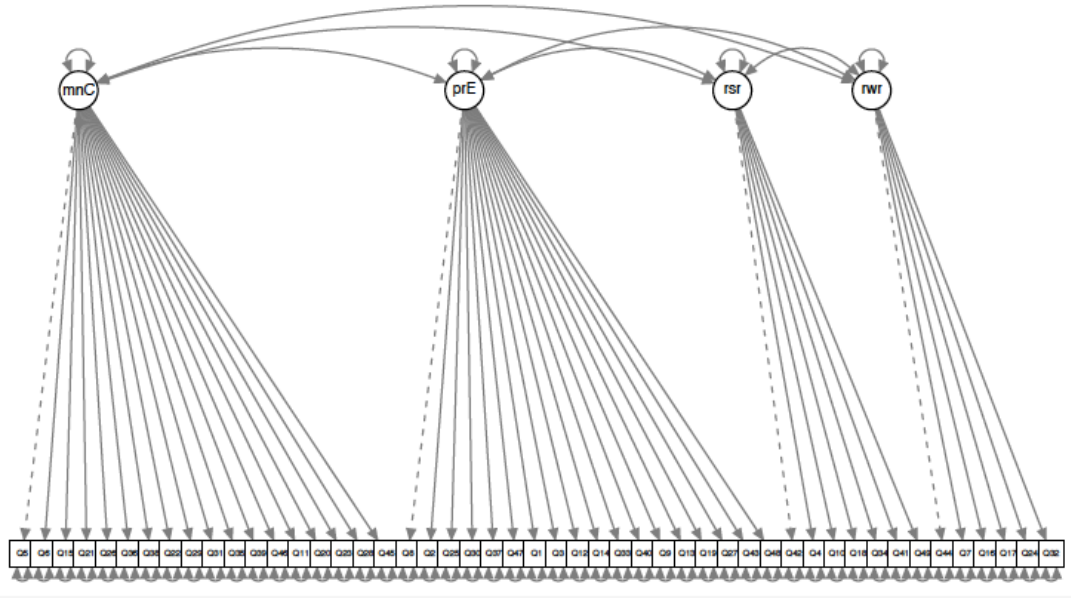

Figure 4. Model A (4 factors⇔49 items) represents the hypothesized four-factor structure (Ensminger et al., 2004) accounting for all the common variance among the 49 items (observable measures).

Model B (8 conditions⇔49 items). Model B, shown in Figure 5, was specified to answer RQ1b. The lavaan package R syntax (Rosseel, 2012) was used to indicate the IPI-II's 49 items to load on Ely's (1990a) eight conditions of Commitment (cmm), Dissatisfaction with Status Quo (dss), Leadership (ldr), Skills and Knowledge (knw), Time (tim), Resources (rsr), Incentives and Rewards (rwr). The conditions cmm, dss, ldr, knw, tim, and rwr were each restricted to their six measured observables. Seven of the IPI-II's items were restricted to the condition Resources (rsr). The dataset containing the number of responses was used to fit Model B. The model is visualized in Figure 5. CFA is appropriate to test this hypothesized relationship since there is one layer of latent variables. Model B standard factor loadings are presented in Table D2 located in Appendix D.

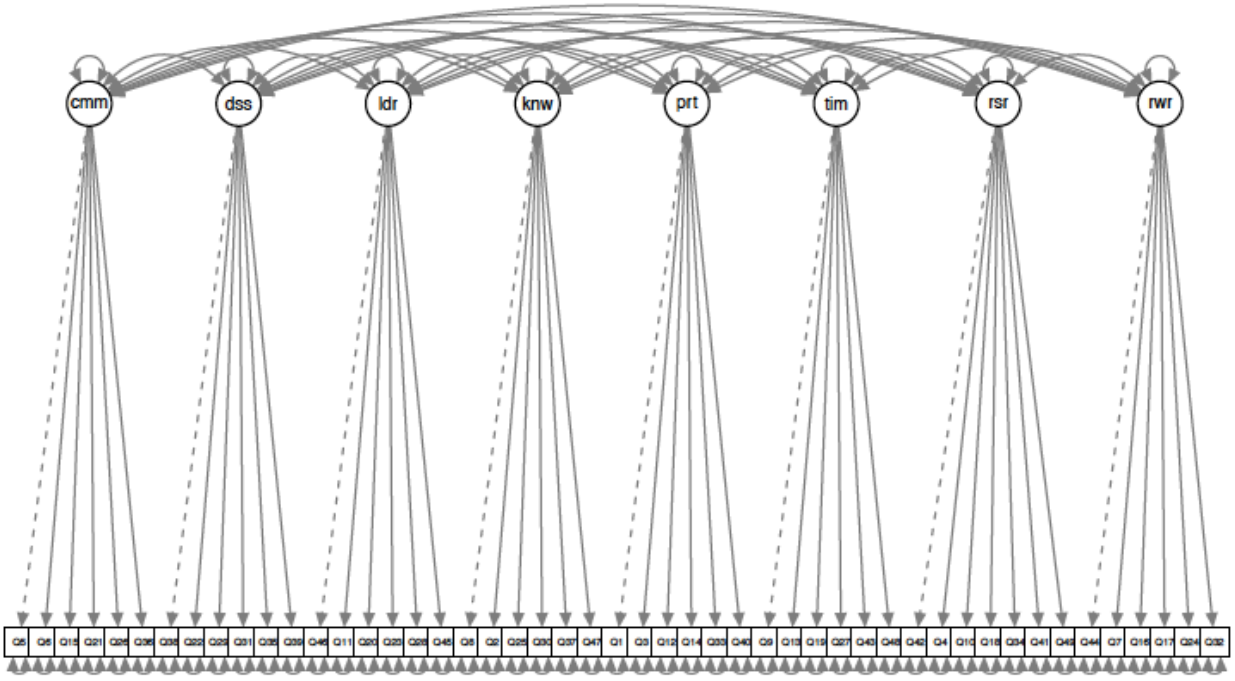

Figure 5. Model B (8 factors⇔49 items) represents Ely's (1990a) eight conditions accounting for all the common variance among the 49 items.

Model C (4 factors⇔8 conditions⇔49 items). Model C, shown in Figure 6, was specified to answer RQ1c. Structural equation modeling (SEM) was used to test the hypothesis of Ely's (1990a) eight conditions and the higher order factor structure. Model C was specified using the lavaan package R syntax (Rosseel, 2012) indicating two layers of latent factors in which Ely's (1990a) eight conditions are restricted to load on the four higher-level factors: Managed Change, Performance Efficacy, Resources, and External Rewards (Ensminger et al., 2004). The dataset containing 252 responses was used to fit Model C.

Since there are two layers of latent traits, SEM (a generalization of CFA) is appropriate to analyze this alternative factor structure model. SEM provided the ability to simultaneously model fit between two layers of latent variables. Ensminger et al. (2004) hypothesized the four latent traits that explain Ely's eight conditions. SEM method allows the modeling of these two layers of latent traits, in contrast to CFA method, which is limited to modeling one layer of latent traits (D. Berry, personal communication September 16, 2016). Model C standard factor loadings are presented in Tables D3 and D4 located in Appendix D. Model C is visualized in Figure 6.

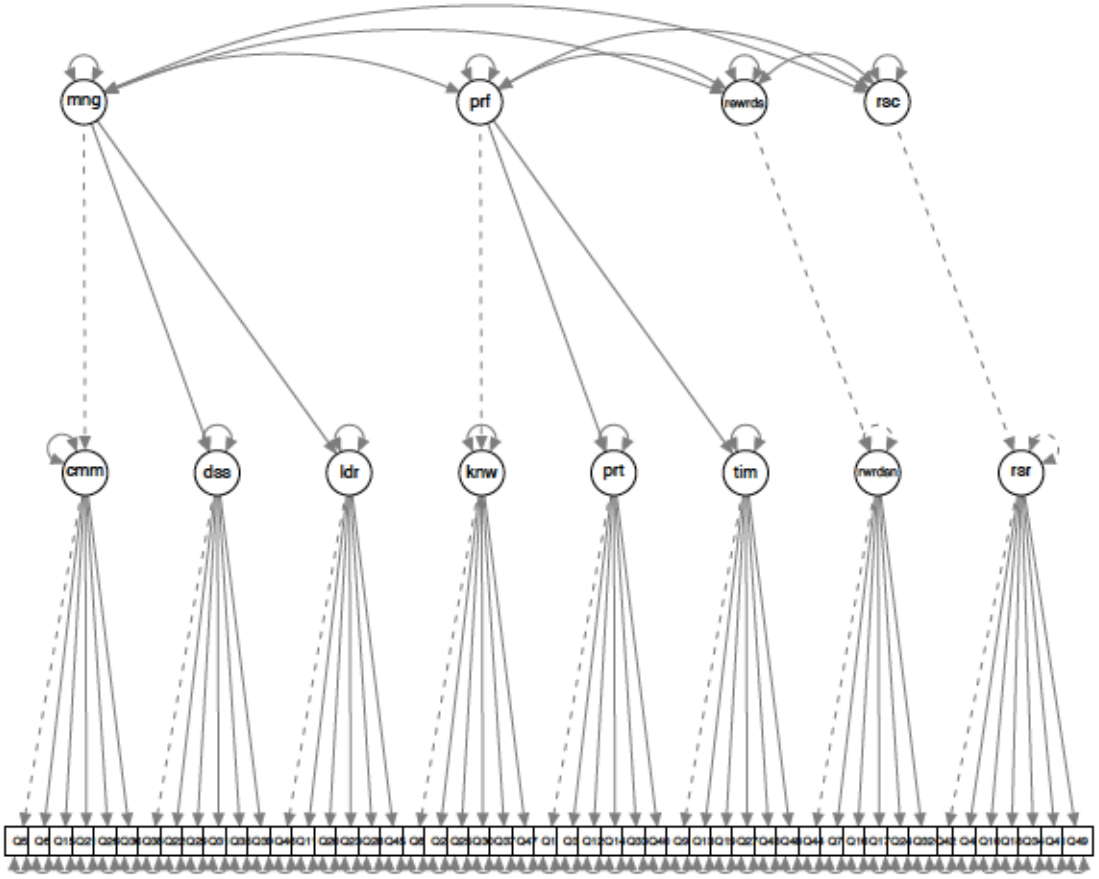

Figure 6. Model C (4 factors⇔8 conditions⇔49 items) represents two layers of latent factors. Layer 1 represents of Ely's (1990a) eight conditions and their relationship to the 49 items. Layer 2 represents the four latent factors -Managed Change, Performance Efficacy, Resources, and External Rewards as conceptualized and named by Ensminger et al. (2004) and their relationship to Ely's (1990a) eight conditions.

Criteria for Comparing Model-Data Fit

"Model fit refers to the ability of a model to reproduce the original covariance matrix" (Beaujean, 2014, p. 153). It is standard practice in CFA studies to report fit measures for models and by default, the lavaan package computes multiple fit measures. The current study provided an overview of three fit indices for the alternative factor structure models within CFA. There are numerous measures of goodness-of-fit for CFA (Brown, 2015; Furr & Bacharach, 2014; Giles, 2002). Based on a meta-analysis by Jackson, Gillaspy & Pure-Stephenson (2009), the three fit

measures reported most frequently were Chi-square, root mean square error of approximation (RMSEA), and comparative fit index (CFI). Using fit indices in CFA to determine how well a model fits the data is highly contentious (Beaujean, 2014; Brown, 2015). Whereas fit indices represent a key set of results, parameter estimates were given more attention in the current study based on the assumption that, ultimately, what drives the goodness-of-fit or reasonableness of a model is theory (Beaujean, 2014) and theory grounds and supports the operationalization of the constructs. Fit indices are duly noted in the current study as the author of the current study anticipates the fit indices will be important when considering factor structure model modifications.

The chi-square *p* value statistic is the most frequently reported fit index in CFA studies; but is difficult to interpret in the current study based on testing the *hypothesized* factor structure of a *revised* instrument. Chi-square *p* value is "non-significant" (i.e, *p* value > 0.01) when the value is large and "non-significant" is indicative of a good fitting model. A small *p* value (i.e, *p* value < 0.01) is considered "significant" and is indicative of a poor fitting or inadequate model. However, a small or significant Chi-square *p* value does not necessarily mean the model is not useful (Brown, 2015; Furr & Bacharach, 2014; Jackson, et al., 2009). Chi-square *p* values, as only one index of model fit, may lead researchers to fail to reject an unreasonable model in a small sample size or reject a reasonable model in large sample size.

Additional measures of fit have been developed and are commonly used to evaluate individual measurement models (Hoyle, 2000; Reise, Waller, & Comrey, 2000). For the two additional goodness-of-fit indices used to report findings in the current study, Furr & Bacharach (2014) provide guidelines for the values, which are recommended to indicate a good fit by RMSEA as ≤ .06 and values of ≥ .95 for CFI. RMSEA is an "error of approximation" index and

assesses the reasonableness of model fit. RMSEA represents a perfect fit with a value of 0 and anything greater than 0 suggests the model is not a perfect fit. CFI compares the fit of a target model to the fit of an independent model. A larger CFI value (closer to 1.0) indicates a better fit.

Research Design

An online questionnaire, using Surry and Ensminger's 49 items developed to measure Ely's eight conditions, was designed as the mechanism for gathering data. The relevant literature and input from the instrument's developers helped to confirm the alignment of the survey items with Ely's (1990a) eight conditions for change and frame the methodological approach for collecting the sources of evidence germane to validation of interpretation and use of the results. The instrument design process for the current study was restricted to the design of the online survey. A group (n=11) of faculty, staff, and graduate students representing a sampling of the target population was recruited to review survey directions for clarity, and beta test the questionnaire for de-bugging purposes. The resulting feedback was essential in addressing problems that might occur during administration and was used to check for clarity of directions, correct spelling and grammar, and ease of questionnaire navigation. However, for purposes of evaluating the psychometric properties of the IPI-II, no changes were made to the 49 stand-alone statements used in the online questionnaire, or the scale generated by Surry and Ensminger (n.d.).

Research instrument and administration. The instrument used in the current study was the Implementation Profile Inventory, second edition (IPI-II). IPI-II was generated from the original IPI, developed by Surry and Ensminger (2002; 2004) based on research which attempted to determine which of Ely's (1990a) eight conditions were perceived as more important by users of a new technology. The IPI-II is a 49-item scale designed to measure perceptions of the

importance of Ely's eight conditions of change, significantly revised in order to collect normative data. Each questionnaire item presents a self-relevant statement (e.g. "In my opinion, top level managers who visibly support an innovation make change easier".). Respondents were asked to rate their level of agreement with each statement anchored by 1=Strongly disagree and 7=Strongly agree on a 7-point Likert scale.

The difficult work of developing content and construct validity of the IPI-II's 49 items was conducted by Ensminger and Surry based on outcomes from studies in 2004 and 2005 using the original IPI. The current study investigated the hypothesized four-factor structure assumptions by testing three plausible alternative factor structures and reported the corresponding findings.

The survey (Appendix E) was administered using the online survey tool Qualtrics. Qualtrics is regularly used at the university, is cost effective for sampling a large population, and was therefore considered the most appropriate method for data collection. The introduction page of the questionnaire provided a description of the study, confirmation of human subject approval by the IRB, consent information, and instructions for completing the questionnaire. Due to the low risk nature of the survey, clicking the link to start the questionnaire implied consent.

The survey consisted of three parts: (I) introductory material, (II) 49 content items related to user perceptions of the importance of Ely's (1990a) eight conditions before or during the implementation of the new LMS, and (III) user characteristics and demographics.

The 49 statements in Part II of the survey, were generated by Surry and Ensminger based on outcomes and recommendations of Ensminger's (2005) study. In order to reduce survey pattern bias, statement order was randomized in the survey through a Qualtrics feature. For ease of locating items by the eight conditions or four higher-level factors, Appendix F organizes the

survey statements by their relationship to Ely's (1990a) eight conditions and their loading on the hypothesized four-factor structure (Ensminger et al., 2004).

Participants

The sample frame for the current study was university employees who function in an administrative or instructional capacity. Participants were contacted through their university email. The University Registrar maintains this list and it is available in the public domain via the university website. The specific population of interest was faculty, staff, and teaching assistants who have implemented or are planning to implement the new learning management system (LMS). An invitation to participate in the study was sent via email with a link to the survey embedded in the email. Eligible individuals were identified at the point of data collection in a single stage sampling designed for convenience and low cost (Fowler, 2002). The sample for the study included employees who volunteered to participate.

In order to situate and personalize participation in the study, participants were asked to consider a new technology on their campus as they responded to the statements in the survey. The new technology was a learning management system (LMS) made available to early adopters Fall 2015. The new technology was fully implemented Spring 2016. The LMS implementation project requires faculty, teaching assistants, and some administrative staff to transition from the old to the new system, and is a widespread innovation at the university.

Prior to the data collection, approval for use of human participation was obtained from the university Internal Review Board (IRB). See Appendix G for IRB protocol approval letter. Data gathering was facilitated by use of an online survey. Email addresses for potential participants were obtained from University Registrar information residing in the public domain. Responses

were anonymous and respondents were not tracked by email address or IP address. One data set was collected through a cross-sectional self-administration of the survey.

Protection of participants. The protection of the participants has been maintained through the process required by the university's IRB. These procedures are designed to protect human participants during research activities. Participants were advised in the invitation email and Part I of the survey that by taking the survey they have given their informed consent and that their responses would be anonymous and IP addresses would not be used in any fashion to track participants. Only aggregate data were reported. The results and interpretations, however, are available to the IPI-II developers and any participants requesting the results.

Data Collection

A single stage sampling procedure was used to collect the data (Babbie et al., 2007). An invitation to participate in the study was sent via email with a link to the survey embedded in the email. Participation was determined at the point of data collection resulting in a convenience sample representing the target population. Three hundred fifty-two potential participants clicked the informed consent button at the beginning of the survey. The survey, built with Qualtrics survey software, included information on Ely's (1990a) eight conditions and change, an informed consent, demographic questions, and the IPI-II (49 item survey). Invitation email and survey are found in Appendices J and E, respectively.

There are several preliminary steps to conducting a CFA. The initial steps of clarifying and simplifying the underlying constructs of what was to be assessed and the initial development of the instrument items were carried out in the original IPI studies (Ensminger et al., 2004; Surry & Ensminger, 2002; Surry & Ensminger, 2008; Surry & Ensminger, 2004; Surry et al., 2006). Two additional steps were required prior to conducting the CFA: (1) collection of a large number of

responses to the instrument; and (2) reverse scoring of any negatively keyed items to ensure that all items are keyed in the same direction (Furr & Bacharach, 2014). A response of a 1 for a negatively worded statement was assigned a 7 and a response of a 2 for a negatively worded statement was assigned a 6 and so on (using a 7-point scale). Survey question #5 is an example of a negatively worded statement reading "Upper management support is not necessary for an innovation to be effective.". A response of 1 (Strongly disagree) was reversed and coded as a 7 (Strongly agree) indicating the respondent perceived upper management support to be necessary for an innovation to be effective.

There are numerous rules of thumb concerning minimum sample size needed for a robust CFA solution (Fava & Velicer, 1996; Gorsuch, 1990; Reise et al., 2000) and there are experts in the field who argue that rules of thumb regarding sample size for factor analysis are useless (MacCallum, Widaman, Zhang, & Hong, 1999). Some argue that any number of respondents more than 200 is sufficient when specifying and interpreting measurement models using CFA, as large sample sizes may result in an analysis that detects trivial effects as statistically significant, resulting in questionable parameter estimates (Brown, 2015; Statistics Solutions, 2013). The resulting n = 252 was considered acceptable for this study.

Data preparation. Essential steps in fully preparing data for the confirmatory factor analysis included a search for missing data and reverse coding of negative statements. For data preparation, the Statistical Package for the Social Sciences (SPSS, 2007) version 21.0 was utilized. Eight of the 49 items were reverse coded (1, 5, 8, 9, 38, 42, 44, and 46) allowing all items to be interpreted in the same direction. SPSS was used to run a frequency on the 352 responses to the survey. Listwise deletion was used on 100 respondents who chose not to answer any questions or abandoned the survey partway through.

Missing data treatment. To increase the amount of data used in the primary analysis, missing values in the remaining 252 responses were assumed to be unrelated to the variable itself and found to be missing completely at random (MCAR). A one-time mean imputation method was used to fill in the missing values in the dataset with estimated item values. Twenty-one of the remaining 252 respondents (n = 252 after listwise deletion) failed to click on one or more of 19 of the 49 items resulting in 24 missing data points. Mean imputation is a commonly used statistical method to address missing data (Babbie et al., 2007).

The methods of listwise deletion and one-time mean imputation used to clean the dataset resulted in an n = 252. CFA interpretation and subsequent steps were conducted on 252 responses to the 49 items in the questionnaire.

Data Analysis

After completion of the essential steps in data preparation of addressing missing data and reverse coding of negative statements (as described earlier in this chapter), a preliminary analysis of the data proceeded with a determination of descriptive statistics to provide background knowledge for the study sample and those measures appropriate for the variables in the study. jMetrik software was utilized (Meyer, 2014) to run frequency distributions and basic measures of central tendency for demographics and item variables. jMetrik analysis provided additional sources of evidence relevant to the reliability and validity of the IPI-II

In order to identify additional sources of evidence relevant to the reliability and validity of the scores of the IPI-II, jMetrik software was used to provide mean (also known as item difficulty), SD, and item discrimination. These item statistics serve as measures of confidence in the items and the instrument overall. R programming was used to generate the diverging stacked bar charts representing frequencies of item responses in Figure 7.

To evaluate the ability of the IPI-II to measure the latent variables (Ely's eight conditions and the four higher level factors hypothesized by Surry and Ensminger), CFA was utilized for the analysis of the alternative factor structure models for delineating the constructs and how the constructs relate to one another. CFA was used to describe the relationships between the latent variables, thus providing a quantitative test of the alternative factor structure models while providing evidence of internal consistency reliability and validity via parameter estimates (Brown, 2015; Furr & Bacharach, 2015).

Alternative factor structure models. In the current study, three plausible alternative factor structures were developed and evaluated to determine to what extent the hypothesized four-factor structure adequately represented the factor structure of the IPI-II and to test for better fitting alternative factor structures. The three alternative factor structure models were specified and translated into lavaan, an R package for latent variable analysis (Rosseel, 2012) in order to test the factor structures. Factor analysis was computed using the lavaan package also. The lavaan package was developed to provide researchers with a free, open-source, commercial-quality software comparable to the current LISREL, EQS, AMOS, and mPlus with a long-term goal of making latent variable models more accessible to researchers (Rosseel, 2012). The lavaan package allows the researcher to enter the model specifications using R syntax for the measurement model and use CFA on the dataset, which contains the latent variables. The lavaan package contains procedures for fitting a variety of latent variable models such as CFA or structural equation models (SEM). The lavaan package also provides parameter estimates and computes standard errors using a variety of techniques.

An additional software package called semPlot was used to generate the visualizations found in Figures 4, 5, and 6 (Epskamp, 2015). The latent variable analysis provided the function of drawing a path diagram to represent the specifications of the alternative factor structure models.

Specifications for the three plausible alternative models are represented graphically in Chapter Four by typical factor-analytic figures called path diagrams. The path diagrams represent key parameter estimates obtained in the analysis by illustrating which items (observable measures) were linked to (load on) each factor (latent variable). These explanatory drawings are called path diagrams. The output path diagrams represented the results of the CFA and showed what was actually observed from the data gathered for the current study.

Summary

The current study examined the reliability and validity evidence yielded by the IPI-II in a sample of university faculty and staff. The IPI-II is a revised psychometric instrument designed to measure user perceptions of the importance of Ely's (1990a) eight conditions that facilitate the implementation of an educational technology innovation. There was no published reliability or validity evidence for the IPI-II and the instrument has not been used in research to date (D. Ensminger, personal communication May 12, 2015).

The exploratively derived hypothesized four-factor structure tested in the current study consists of the following constructs conceptualized and named by Ensminger and colleagues (2004): Managed Change, Performance Efficacy, Resources, and External Rewards. The measured outcome in the current study was the user's (faculty, staff, and teaching assistants) perceived importance of Ely's (1990a) eight conditions of change: Commitment, Dissatisfaction with Status Quo, Leadership, Knowledge and Skills, Participation, Time, Resources, and Rewards and Incentives.

The questionnaire used was pre-tested for clarity by a group of faculty, staff, and graduate students representing a sampling of the target population. Study participants were invited via an email, which provided a link to the survey. The instrument used to gather data was made available as an online Qualtrics survey. The survey included an explanation of the study along with directions and informed consent. The survey included the 49 items from the IPI-II. Finally, the survey included a series of demographics questions. The survey yielded 252 usable responses.

In order to rigorously and systematically test the goodness-of-fit of Ensminger, et al.'s (2004) hypothesized factor structure obtained from exploratory factor analysis, three plausible alternative factor structures were proposed. CFA was used to specify and fit the three alternative factor structure models and path analyses to produce the path diagrams. The analysis indicated the strength of the relationships between the items and the factors. CFA is a multivariate technique used to examine hypothesized measurement models using a prior criteria to access model fit and confirm factor structure of a measurement instrument. Whereas, there are myriad plausible alternative factor structures that could be tested, for clarity concerning the fit of the hypothesized four-factor structure, three alternative models were tested.

Chapter Four presented the results of the analyses described in this chapter. Data analysis was based on data gathered from a sample of university faculty and staff (n=252). Additionally, along with demographics for the respondents, item frequencies and measures of central tendency were presented for the dataset.

Chapter Four

Results

This chapter presents results of the data analyses used to answer the research question. The key question of the current study was: What are the psychometric properties of the Implementation Profile Inventory II, a revised measure of Ely's conditions of change? In order to answer the key question, three sub questions were used to guide the development and examination of reliability and validity evidence:

RQ1a: What psychometric information can be obtained from an analysis in which the four-factors hypothesized to underlie Ely's eight conditions were measured using 49 questionnaire items?

RQ1b: What psychometric information can be obtained from an analysis in which Ely's eight conditions were measured using 49 questionnaire items?

RQ1c: What psychometric information can be obtained from an analysis in which the four higher level factors and Ely's eight conditions were simultaneously measured using 49 questionnaire items?

Chapter Four presents fit indices and parameter estimates for the three alternative factor structures, and item analysis used to examine the reliability and validity evidence yielded by the IPI-II in a sample of university faculty and staff. Ensminger and colleagues (2004) hypothesized underlying relationships emerging from Ely's framework of change consisting of the latent constructs of Managed Change, Performance Efficacy, Resources, and External Rewards. The current study tested the consistency of the hypothesized four-factor structure (Ensminger et al., 2004) of Ely's (1990a) eight conditions and evaluated additional facets of the psychometric

properties of the IPI-II: an instrument designed to measure user perceptions of the importance of eight conditions that facilitate the implementation of a new technology.

The data collected in the survey represented the perceptions of university faculty and staff of the importance of Ely's (1990a) eight conditions of change when implementing or considering implementing a new educational technology. An application for the Institutional Review Board's (IRB) protocol approval was submitted and approved in May of 2016 (IRB #16-004). Participation of university employees was solicited via an email invitation sent May 17, 2016. The online survey was closed June 24, 2016. The data were analyzed during the summer and fall of 2016 through collaboration with the university's Laboratory for Interdisciplinary Statistical Analysis.

Preliminary Analysis

The purpose of the current study was to provide reliability and validity evidence to substantiate the IPI-II's use as a measure of a user's perceptions of Ely's (1990a) eight conditions of change. The study sample consisted of 252-university faculty, staff, and teaching assistants using or planning to use the new learning management system (LMS). The data used in the current study were collected through a cross-sectional, self-administered questionnaire (Lavrakas, 2008). Descriptive statistics for the demographic variables were provided as a snapshot of the referent population.

Demographics. Prior to addressing the key research question, statistical data relating to the sample population for this study were examined in a general way. R syntax was used to generate summary tables for the demographic questions in the survey. For the purpose of background information: age, gender, role within the organization, years in education, years at the university, college affiliation, level of proficiency with technology, and current use of the new

technology were presented. In the current study, the nine demographic items added to the survey serve only to describe the referent population.

A summary of the percentages of participant demographic information is presented in Tables H1 and H2 in Appendix H. Of the participants who responded to the demographic questions, the majority were male (52%), between the ages of 55- 64 (31 %), teaching and research faculty (64%), affiliated with the College of Liberal Arts and Human Sciences (21%) and with an intermediate level of proficiency with technology (52%). The average respondent had been teaching for 17 years with 13 of those years at the university.

Item statistics. All item measures were calculated based on a seven-point Likert scale, where 1 = Strongly disagree and 7 = Strongly agree regarding the respondents' perception of the importance of the statement measuring one of Ely's (1990a) eight conditions. Item response frequency, along with item range, mean, discrimination, and standard deviation for the 49 items in the IPI-II are tabulated and presented in Table I1 (Appendix I).

The stacked bar chart (Figure 7) provides a comprehensive picture of item response frequencies. The statements that accompany the item numbers can also be found in Appendix I. The items loading on Ely's (1990a) conditions of Time, Skills and Knowledge, and Resources consistently have the most responses of 'Agree' and 'Strongly agree' (Q2, Q4, Q7, Q9, Q10, Q13, Q18, Q19, Q21, Q27, Q29, Q34, Q41, Q42, Q43, and Q48). Ensminger et al. (2004) hypothesized these conditions to cluster on the factors of Performance Efficacy and Resources.

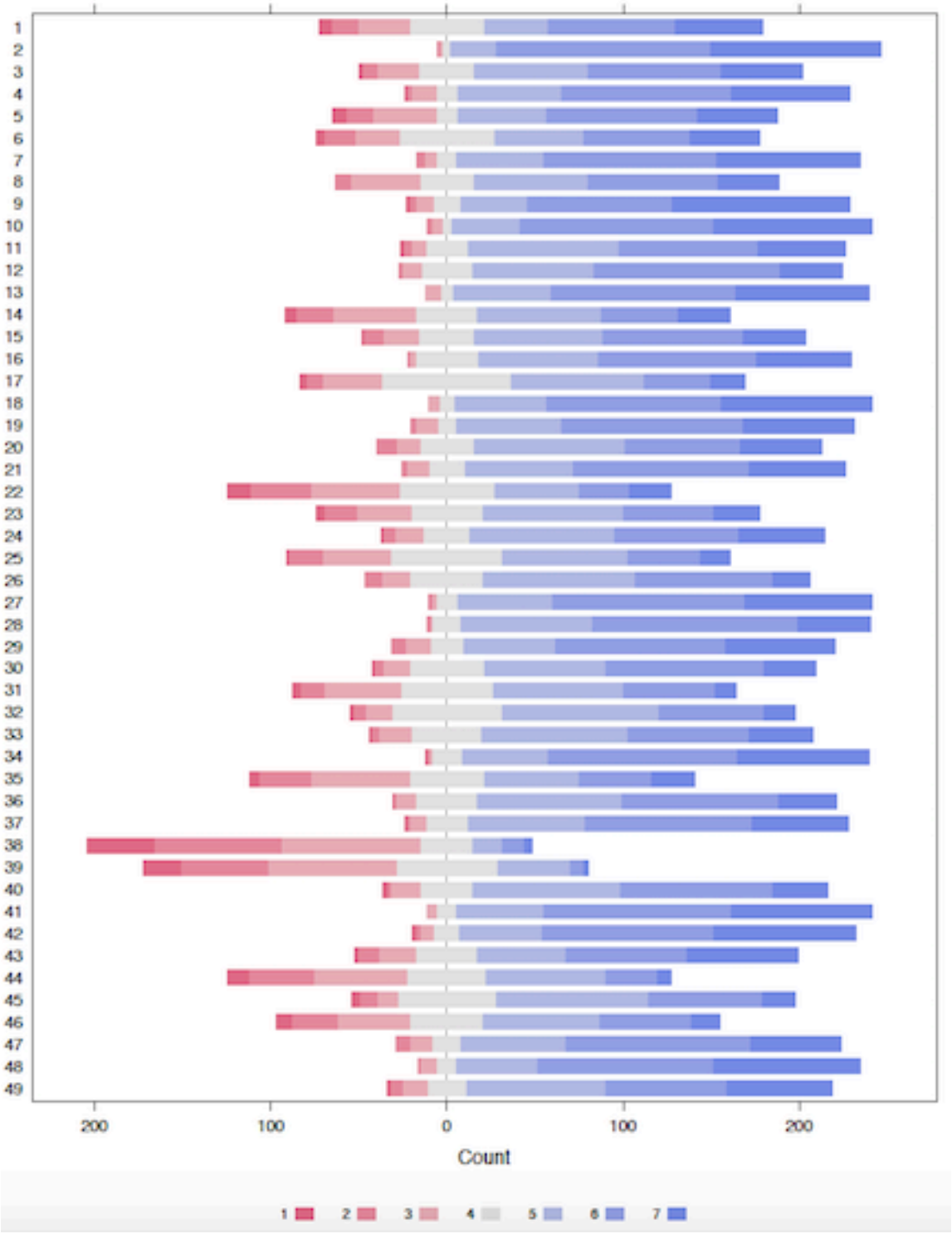

Figure 7. Diverging stacked bar charts representing frequencies of item responses. N = 252. 1=Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree nor disagree, 5=Somewhat agree, 6=Agree, 7=Strongly agree. Item statements by number can be found in Appendix I.

Primary Analysis

The primary analysis was completed to address the key research question and sub questions in the current study. Confirmatory factor analysis was procedure used to test the hypothesized four-factor structure, which emerged from a study by Ensminger and colleagues (2004), by comparing the measurement model to three plausible alternative measurement models for the IPI-II. CFA is employed when the research is based on strong theory, the constructs have been previously defined, and the instrument items have been designed to measure particular constructs. CFA procedures allow model evaluation by providing goodness-of-fit indices in addition to the statistical significance, direction, and size of parameter estimates based on model specifications fit to a dataset (Brown, 2015).

Collaboration with a team of statisticians led by Daniel Berry, produced a report that provided a factor analysis of the three alternative factor structure models. The factor analysis report with minimal annotations and the R markdown format file are provided by the author as supplemental material. Information on how to access the supplemental materials is provided in Appendix L. The statisticians' expertise with R programing syntax allowed them to move easily through several latent variable analysis packages (lavaan package and semPlot). Graphics illustrating CFA solutions (path diagrams) for the alternative factor structure models were generated and are presented in this chapter. The factor analysis report in its entirety is available as linked supplemental electronic material. Information on how to access this report is provided in Appendix L.

Alternative factor structure model descriptions. The hypothesized four-factor structure (Ensminger et al., 2004) was tested using three alternative factor structure models, which required that several confirmatory factor analyses be conducted. For each model, structural

equation modeling (SEM) procedures (specifically CFA for Models A and B) provided the number of observations (N = 252), variables, along with estimated and standardized parameter values. Estimated (unstandardized) parameters are always relative and the scale will change based on which item serves as the marker indicator; thus, making it impossible to create threshold values or cut off scores for reporting purposes (Hoyle, 2000). Only standardized parameter values will be reported in the tables created to facilitate interpretation. Values for factor loading(s) are considered weak in the 0.10 to 0.30 range, >0.30 to ≤ 0.50, are considered moderate and > 0.50 are considered strong (Stevens, 2012).

Parameter estimates are key when assessing model fit and there are several types of parameters that can be estimated (Furr & Bacharach, 2014). Factor loading(s) for each item in the instrument are estimates of the strength of that item's ability to measure the factor it was constrained to load on (the assumption is that it is non-zero). Another type of parameter estimate occurs in a multi-dimensional instrument showing the strength of correlations between lower-order factors on higher-level factors. There are additional parameters estimates that can be reported (e.g., error variances); however, the item-factor parameters and the factor-factor parameters are the two that are important to the current study. Figures 4, 5, and 6 represent the path diagrams for the alternative factor structure model solutions, graphically illustrating the parameter estimates. Tables D1, D2, D3, and D4 (Appendix D) present detailed standardized parameter estimates (factor loadings) for the three alternative factor structure model solutions.

CFA procedures provided fit statistics based on the plausible a priori specifics to access model fit and provide additional evidence concerning the factor structures' ability to reproduce the data. The examination of goodness-of-fit indices, allowed the researcher to determine the significance and efficacy of the models (Brown, 2015). The goodness-of-fit indices are a

measure of how well the specified model fits the observed data. The three fit indices used in the current study to examine goodness-of-fit of the alternative factor structures were Chi-square, Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI).

Chi-square was used to compare observed data with data that were expected to be observed. Chi-square requires the use of numerical values and uses a formula to produce a *p* value indicating the probability that any variation from the expected results is due to chance only (Osterlind, 2006). A p value < 0.05 is generally considered an indication that a model is a poor fit. RMSEA is used to indicate the amount of unexplained variance in the data. Like the Chi-square value, the smaller the number the less evidence there is of a good fitting factor structure model. A RMSEA value of $\geq .06$ is considered indicative of a potentially poor fitting model. CFI is an additional fit index to use when considering acceptable model fit. CFI is a normed fit index (values cannot exceed 1.0) that accounts for sample size and works well with large or small sample sizes (Byrne, 2012). Values for this fit statistic range between 0.0 and 1.0 with values closer to 1.0 indicating a better fit.

To verify reasonableness of the model, key results were examined in addition to the three fit statistics. After ensuring the alternative models were based on existing theory and empirical evidence, it was determined they made both statistical and practical sense. Standardized parameter values were examined for out-of-range values (i.e. standardized correlations greater than 1.0 or negative values for indicator variance). In reporting the pattern of findings, the strength of the relationships between the 49 questionnaire items and the factors (both Ely's eight conditions and the four higher-level factors) were used. Values for correlation coefficients were considered weak in the 0.100 to 0.300 range, >0.300 to ≤ 0.500 are considered moderate and

>0.500 are considered strong (Stevens, 2012). All items and conditions were hypothesized to load in the positive direction.

Model A (4 factors⇔49 items). In this model, the fit was based on the 49 items loading on the hypothesized four higher-level factors shown in Figure 4.

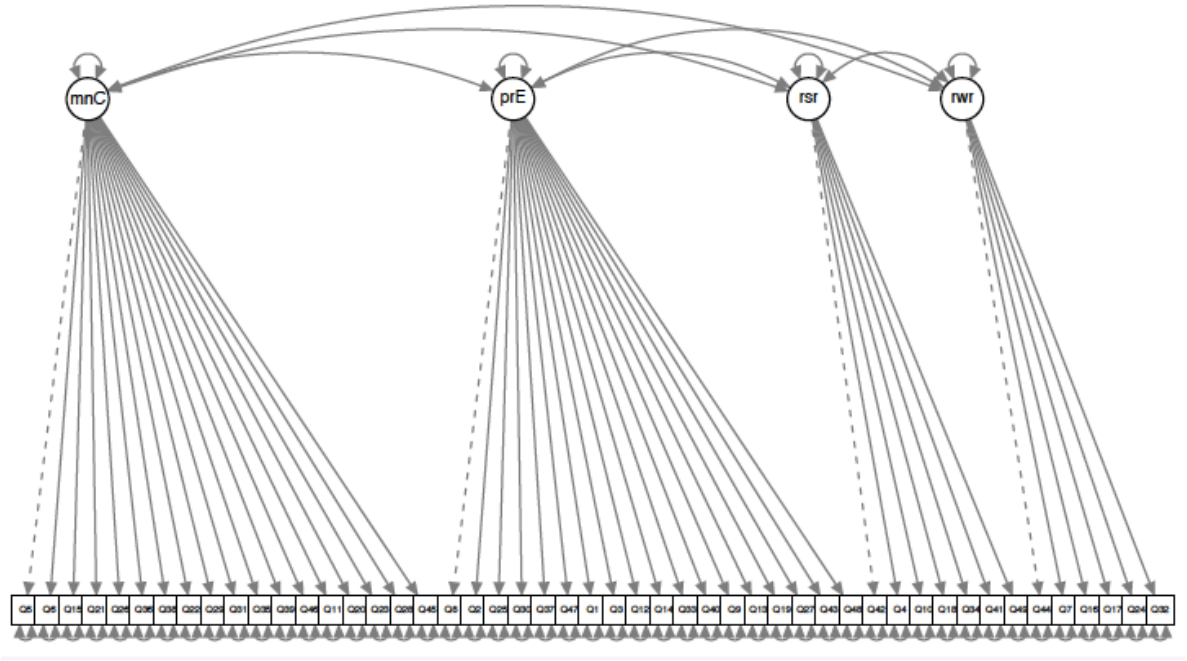

*Figure 4***.** Model A (4 factors⇔49 items) – in this model, a four-factor model accounted for all the common variance among the 49 items (observable measures).

In fitting the reduced four-factor model to the 49 items, there is little evidence of good fit. Table 8 provides a summary of the overall fit measures observed for the three alternative factor structures. The Chi-square value for the single-level, four-factor CFA model was $p < 0.01$. The alternative measures of fit, which are less sensitive to sample size than Chi-square *p* value, suggest that the fit for Model A is poor. The RMSEA of 0.078 is larger than Models B and C, and the CFI of 0.646 is smaller than Models B and C.

The standardized factor loadings for 39 of the items ranged from moderate (Q8=0.309 "Most people can simply figure out how to use an innovation, no special training is required" reverse

coded) to strong (Q41=0.815 "Having access to the necessary support materials and tools is critical to the successful implementation of an innovation"). All six items measuring Dissatisfaction with Status Quo (DSS) had very weak factor loadings, ranging from a low of negative 0.351 (Q38 "We should always be open to new methods, even if the current methods are working well" reverse coded) to a high of 0.065 (Q29 "I am more willing to accept innovations if I feel the old ways are not working very well").

Two items measuring Leadership were weak in relation to the factor Managed Change. Q46=0.285 ("Once the innovation has been adopted by the organization supervisors have little impact on its use" reverse coded) and Q20=0.280 ("Low and mid level managers who are opposed to an innovation can kill the innovation easily, even if upper level managers support it").

One item Q1=0.090 ("Trying to get input from those responsible for using an innovation won't have any effect on the innovation anyway" reverse coded) measuring Participation was weak in relation to the factor, Performance Efficacy. One item Q16=0.297 ("Achieving a sense of personal satisfaction will make me more likely to use an innovation") measuring Incentives and Rewards, was weak loading on the factor External Rewards. Table D1 (Appendix D) reports the standardized factor loadings for Model A (4 factors →49 items), which can be interpreted as correlation coefficients for the four-factor structure.

The estimation of Model A suggested that the model did not provide a good fit as indicated by the chi-square *p* value and the CFI value. In addition, the path coefficients between the condition Dissatisfaction Status Quo and the six observed measures showed a weak relationship to Managed Change (as indicated in the study by Ensminger et al., 2004). Model A provides

evidence for the hypothesized four-factor structure; however, the evidence indicated a weaker fit than models B and C.

Model B (8 conditions⇔49 items). In this more flexible model, the fit was based on the 49 items loading on the factors (Ely's eight conditions) they were purported to measure shown in Figure 5. For this model, the Chi-square *p* value is reported at 0.01. The alternative measures of fit, which are less sensitive to sample size than Chi-square *p* value, suggested that the fit for Model B was reasonable. The RMSEA of 0.064 is considered fair, and the CFI of 0.768 is close to 1.0.

Table D2 (Appendix D) reports the standardized factor loadings for Model B (8 conditions⇔49 items), which can be interpreted as correlation coefficients for the 49 IPI-II items' relationship to an eight-factor structure. Figure 5 is the path diagram for Model B.

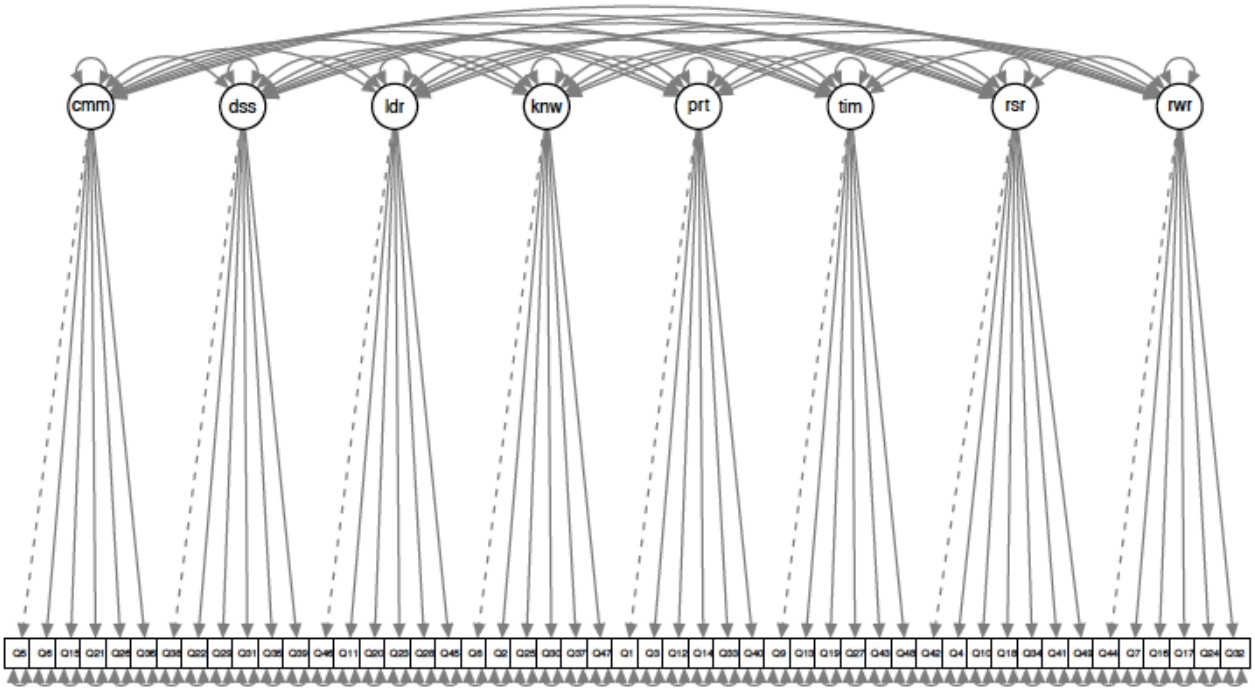

Figure 5. Model B (8 conditions⇔49 items) represent Ely's (1990a) eight conditions accounting for all the common variance among the 49 items.

All six items measuring the condition Commitment (cmm Q5, Q6, Q15, Q21, Q26, Q36) show a moderate to strong relationship with values ranging from 0.429 (Q6 “I want tangible commitment not just basic lip service from the top-level executives before I consider using an innovation”) to 0.797 (Q26 “Senior management’s actions are pivotal in fostering the implementation of an innovation”).

Five of the six items measuring the condition Dissatisfaction with Status Quo (dss Q38, Q22, Q29, Q35, Q39) show a moderate to strong relationship with values ranging from 0.365 (Q39 “Creating a sense of dissatisfaction with the status quo is critical to the successful implementation of an innovation”) to 0.890 (Q35 “It is important for me to feel that the current way we do things is not working before I consider a change”).

Five of the six items measuring the condition Leadership (ldr Q46, Q11, Q23, Q28, Q45) show a moderate to strong relationship with values ranging from 0.304 (Q46 “Once the innovation has been adopted by the organization supervisors have little impact on its use” reverse coded) to 0.796 (Q28 “In my opinion managers and direct supervisors who actively support an innovation make change easier”).

All six items measuring Skills and Knowledge (knw Q1, Q3, Q12, Q14, Q33, Q40) show a moderate to strong relationship with values ranging from 0.340 (Q8 “Most people can simply figure out how to use an innovation, no special training is required” reverse coded) to 0.783 (Q37 “Ensuring that everyone has the required skills and knowledge is critical to the successful implementation of an innovation”).

Five of the six items measuring the condition Participation (prt Q3, Q12, Q14, Q33, Q40) show a strong relationship with values ranging from 0.514 (Q3 “The more everyone participates in the development of an innovation the more successful the innovation will be”) to 0.747 (Q40

"Creating an atmosphere of genuine participation is critical to the successful implementation of an innovation").

Of the 19 items measuring the conditions Time (tim), Resources (rsr), and Incentives and Rewards (rwr), all but one item purporting to measure Rewards or Incentives (Q16=0.300 "Achieving a sense of personal satisfaction will make me more likely to use an innovation") showed moderate to strong relationships with values ranging from 0.350 (Rewards or Incentives Q7 "I am more likely to accept a change if I know I will gain something from it") to 0.827 (Rewards or Incentives Q32 "In my opinion incentives or rewards makes change much easier").

The estimation of Model B (8 conditions⇔49 items) showed a better fit than Model A (4 factors⇔49 items) with a smaller RMSEA and a larger CFI. All eight conditions had five or more items with significant factor loadings. Model B served as excellent validity evidence for the IPI-II's items with consistently strong factor loadings providing strong construct validity for Ely's (1990a) framework for change.

Model C (4 factors⇔8 conditions⇔49 items). For this structural equation model (SEM), the Chi-square value can be interpreted as indicating a poor model fit ($p < .05$). The RMSEA value of 0.067 is fairly reasonable. The CFI value of 0.743 is good. Model C is shown in Figure 6.

Tables D3 and D4 (Appendix D) report the standardized factor loadings for Model C, which can be interpreted as correlation coefficients for the alternative factor structure of 4⇔8⇔49. In this model, the lavaan package simultaneously specified and fit the 49 items to the eight conditions (layer 1) as well as specifying and fitting the eight conditions to the four factors (layer 2). For reporting purposes, the analyses for these two layers of results were separated.

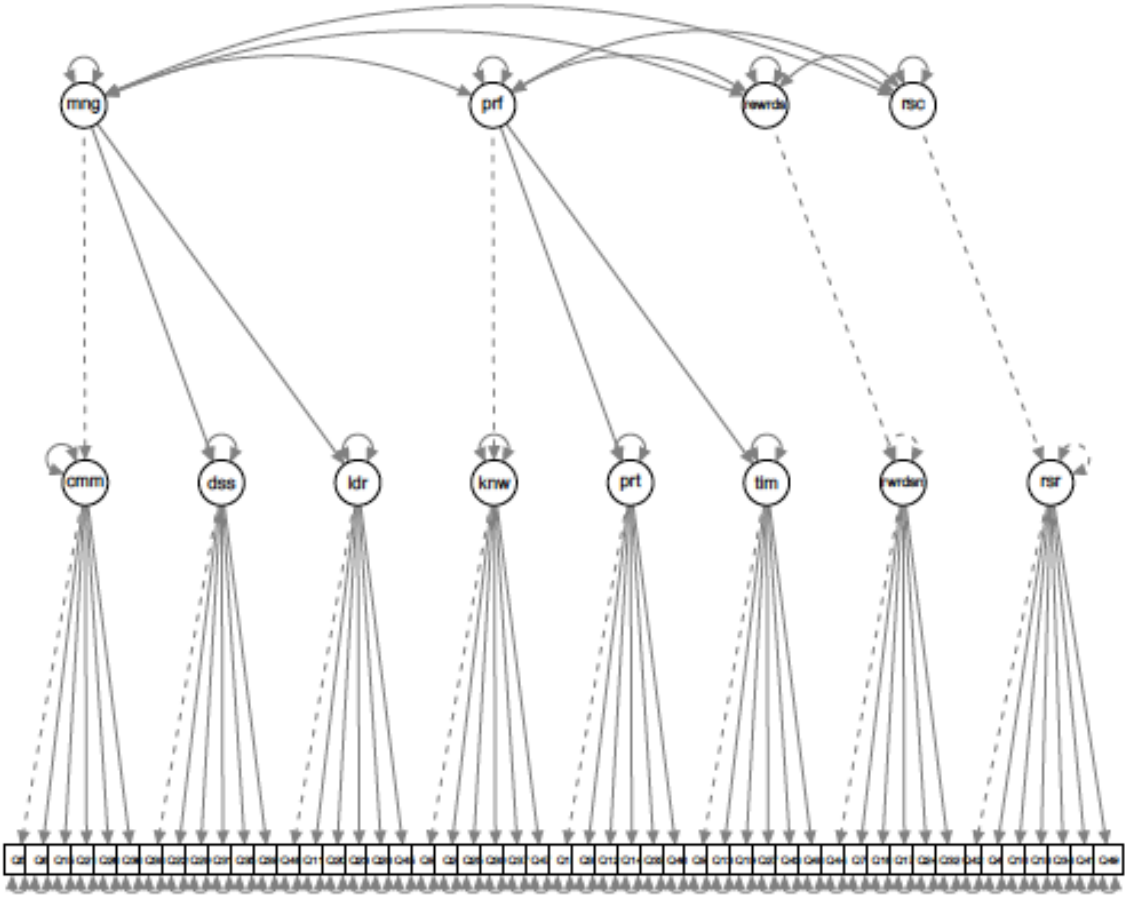

Figure 6. Model C (4 factors⇔8 conditions⇔49 items) represents two layers of latent factors. Layer 1 represents the relationship of the 49 items to Ely's (1990a) eight conditions. Layer 2 represents Ely's (1990a) eight conditions and their relationship to the four latent factors - Managed Change, Performance Efficacy, Resources, and External Rewards as conceptualized and named by Ensminger et al. (2004).

Layer 1 illustrates the 49 items' correlation to Ely's eight conditions and is reported in Table D3 (Appendix D). Layer 2 illustrates the eight conditions' correlation to Ensminger et al's (2004) four factors and is reported in Table D4 (Appendix D). Figure 6 illustrates the items' relationship to the conditions and the conditions' relationship to the four higher-level factors.

Table D3 (Appendix D) reports standardized factor loadings for Model C (layer 1). Factor scores illustrated correlations between the 49 items and Ely's (1990a) eight conditions. The majority of the correlations between items in Table D3 were moderate to strong (with correlation

coefficients between 0.34 and 0.91) in relation to the eight conditions that influence implementation of a new technology and positive in direction. Weak correlations were observed among Dissatisfaction with Status Quo (Q31), Leadership (Q46 and Q20), Participation (Q1), and Incentives and Rewards (Q16).

Table D4 (Appendix D) reports standardized factor loadings for Model C (4 factors⇔8 conditions⇔49 items) layer 2. Factor scores illustrated correlations between Ely's (1990a) eight conditions and the four factors that emerged from the original IPI research (Ensminger, et al., 2004). Very strong relationships between the conditions Commitment (0.95), Leadership (0.97), and the factor Managed Change were indicated by this model. Dissatisfaction with Status Quo showed no correlation with Managed Change with a factor loading of 0.045. Also, a strong relationship between the conditions Skills and Knowledge, Participation, Time and Performance Efficacy was revealed. As theorized, Incentives and Rewards and Resources showed a one-to-one correlation with External Rewards and Resources. Again, as in Model A (4 factors⇔49 items), the parameter estimates from layer 1 and layer 2 in Model C indicate that Ensminger et al.'s (2004) hypothesized four-factor structure is not unreasonable.

The estimation of Model C (4 factors⇔8 conditions⇔49 items) showed two of the three fit indices indicated acceptable model fit and the third index (CFI = 0.743) was close to meeting values for acceptable fit. The path coefficients between the four factors and the eight conditions ranged from .77 to .97 (see Appendix D, Table D4) with the notable exception of Dissatisfaction with Status Quo. Model C provided evidence of the hypothesized four-factor structure and was useful. Model C also strongly suggested the likelihood of a five-factor model yielding a better fit, when Dissatisfaction with Status Quo is not constrained to load on the higher-level factor of Managed Change.

Fit statistics. The goodness-of-fit metrics reported for each model were compared in Table 8. The fit indices for Model A (4 factors⇔49 items) were poor. Models B and C provided modestly better fits to the data. As pointed out in Chapter Three, there is considerable controversy about the use of fit indices in evaluating measurement models; however, they are commonly reported when comparing measurement models using confirmatory factor analysis.

Table 8

Fit Indices for the Three Alternative Factor Structure Models

	Model A (4 factors⇔49 items)	Model B (8 conditions⇔49 items)	Model C (4 factors⇔8 conditions⇔49 items)
Chi-square *p* value	0.01	0.01	0.01
RMSEA	0.078	0.064	0.067
CFI	0.646	0.768	0.743

Notes: Recommended values for good fit: Chi-square ≥.05; RMSEA ≤.06; CFI values closer to 1.0.

Test level statistics. Additionally, the data were used to examine test level statistics. Since reliability is a pre-requisite to validity, appropriate reliability analyses are important to understanding the psychometric properties of a measure.

Coefficient alpha. Coefficient alpha (i.e, Cronbach's alpha) is a popular approach to estimating internal consistency (reliability) at the item level (Furr, 2011). There are differing views on the acceptable values of alpha, ranging from 0.70 to 0.95 (DeVellis, 1991; Furr & Bacharach, 2014) and in spite of its widespread use, researchers have known it to be a mis-estimator of scale reliability (Brown, 2015; Zimmerman & Schunk, 2014). However, due to the ubiquity of reporting coefficient alpha in studies evaluating the psychometric properties of an instrument, the IPI-II's coefficient alpha of 0.9092 is shared as evidence of high internal consistency. jMetrik (Meyer, 2014) analysis of the IPI-II shows a coefficient alpha of 0.9092.

This statistic indicates that the IPI-II is a reliable measure that primarily reflects true score variance and little error variance (Pedhazur & Schmelkin, 2013).

Generally, a coefficient alpha value > 0.70 indicates internal consistency made more interpretable by a uni-dimensional instrument. However, since the IPI-II is hypothesized to be a multidimensional instrument with correlated constructs, the more sophisticated approach of CFA is considered stronger evidence for test level analysis (Brown, 2015). The coefficient alpha of 0.9092 is reported here as a preliminary indicator that the IPI-II has internal consistency. Internal reliability denotes the consistency in measurement of a given respondent's score.

In addition to being an index of reliability, alpha is a function of test length (DeVellis, 1991). With 49 items (6 or more per condition), the high value alpha value (>0.90) may indicate redundancies and provides information (in addition to parameter estimates) on which items could be removed; thus, shortening the test and not detracting from the instrument's reliability.

Item analysis. Table I1 found in Appendix I provides all item response data, in addition to item frequency, Table I1 reports Min., Max., Mean, SD, and Disc. For polytomous items in which there are no right or wrong (Likert scale), hard or easy items, difficulty is represented by mean and is interpreted as endorsability; in other words, how many respondents 'agreed' with or endorsed an item (>4.5). Seven of the 49 items reported a mean <4.5 (DSS Q22, Q35, Q39, and Q38; Know & Skills Q25, Rewards Q44, Leadership Q46). Of the seven items that indicated a general lack of endorsement on the part of participants, three of those were reverse coded in data preparation (Q38, Q44, Q46).

Three items loading on Ely's (1990a) conditions of Dissatisfaction with Status Quo (DSS) (Q22, Q38, Q39) and one item loading on the condition, Incentives and Rewards (Q44) yielded the most responses of 'Disagree' and 'Strongly disagree'. Ensminger et al. (2004) hypothesized

DSS to load on the factor Managed Change and Incentives and Rewards to load on the distinct latent factor, External Rewards. Items Q38 and Q44 were both reverse scored and read "We should always be open to new methods even if the current methods are working well" and "Rewards or incentives rarely influence my decision to use an innovation" respectively.

Additionally, the reliability analysis indicated that overall test reliability would be improved if Q38, Q39, Q44, and Q46 were removed. Q38 and 39 purport to measure the condition Dissatisfaction with Status Quo, Q44 purports to measure Incentives and Rewards, and Q46 purports to measure Leadership.

To interpret the discrimination index for each item, the researcher is looking for how well the item serves to sufficiently differentiate between respondents who 'Strongly agree' or 'Strongly disagree'. There are no clear guidelines on acceptable levels of discrimination; however, Osterlind (2006) indicates ≥.25 is acceptable for operational use, noting that higher discrimination levels are better. Eight of the 49 items showed a poor ability to discriminate between those who endorsed an item and those who did not (Q1, Q9, Q20, Q31, Q38, Q39, Q44, Q46). Four of the items that do a poor job of discriminating between those respondents who agree and those who disagree, overlap with the items participants found difficult to endorse (Q38, Q39, Q44, Q46). Notably, the discrimination index for all Likert values of 3=somewhat disagree and 5=somewhat agree showed little ability to differentiate between those who endorsed an item and those who did not. The relationship between item difficulty and item discrimination is further validated by this overlap representing a one-to-one correlation to the items that would improve test reliability if they were removed (see Appendix K for Table K1 which synthesizes item analysis and identifies items to be considered for removal).

Standard deviation (SD) is reported in Table I1 (Appendix I) as an additional measure useful in describing the set of observations for the current study. In describing the mean of this sample, SD shows that more than 97% of observations fall within the expected two standard deviations. Whereas, SD is a source of reliable evidence of variance for the items in the IPI-II, it is not as important in the confirmatory stage as it is the exploratory phase of instrument development. CFA is a measurement method that constrains or restricts the behavior of the responses, so it would be expected to see a normal distribution of the data values.

Summary

This chapter presented the results of the statistical analyses necessary to answer the research question. Results of a preliminary statistical analysis including demographics as background information were reported. The primary statistical analyses provided an examination of the reliability and validity evidence yielded by the IPI-II and reported goodness-of-fit indices in addition to standardized parameter values for factor loadings based on model specifications fit to the sample for the current study.

Model A (4 factors⇔49 items) indicated that the hypothesized four-factor structure (Ensminger et al., 2004) was not an unreasonable fit to the data; however, more useful to this study was that Model A served to inform the specification and interpretation of models B (8 factors⇔49 items) and C (4 factors⇔8 conditions⇔49 items), which were key to the discovery of a probable five-factor structure for the IPI-II.

The results of Model A informed the specifications for Model B, and those combined results informed the specifications for Model C. The cumulative results from comparing three alternative factor structure models provided evidence supporting Ensminger et al.'s (2004) hypothesized four-factor structure for the IPI-II. However, more importantly, the process of

evaluating the results from the current study provided evidence indicating the likelihood of a five-factor structure as a better fit for the IPI-II, in which Dissatisfaction with Status Quo serves as a higher-level factor.

Model B (8 factors⇔49 items) was more flexible than Model A and provided evidence of a better fit for the current study's data. Additionally, Model B evidence provided construct validity information supportive of the IPI-II accurately measuring Ely's (1990a) eight conditions that influence implementation of educational technology innovations. SEM was run on Model C, providing evidence for the alternative factor structure of 4 factors⇔8 conditions⇔49 items and more evidence for a probable factor structure of 5 factors⇔ 8 conditions⇔49 items in which Dissatisfaction with Status Quo is a separate factor.

Chapter Five presents a discussion of the results from Chapter Four and provides details on the emergence of a five-factor structure as a better fitting factor structure for the IPI-II with the data. Additionally, Chapter Five situates the emergence of Dissatisfaction of Status Quo as a separate factor in the review of literature for the current study.

Chapter Five

Discussion

The purpose of the current study was to provide reliability and validity evidence to substantiate the IPI-II's use as a measure of a user's perceptions of Ely's (1990a) eight conditions of change. The current study filled an important gap in the research of conditions that support implementation of new technologies by providing research on the psychometric qualities of an instrument designed to measure Ely's (1990a) eight conditions of change. Additionally, the current study provided instructional designers with research focused on methods to evaluate the quality of a psychometric measure that is accessible and relatively nontechnical.

Chapter Five highlights the implications for researchers, limitations of the study, and suggestions for future research.

Summary of Findings

No results contraindicating the reasonableness of Ensminger et al.'s (2004) hypothesized four-factor model were produced in the process of answering the research question. There was ample evidence for the multidimensional structure of the IPI-II based on CFA of a sample of university faculty and staff. Of primary interest for the current study was the emergence of a five-factor structure that promised a better fit with the data. In a cumulative fashion, the results of all three models served to suggest that treating Dissatisfaction with Status Quo as a fifth factor in a measurement model would better represent the underlying factor structure of the IPI-II in a sample of university employees. Lastly, the finding of a small number of IPI-II items that proved problematic as measures of certain factors provided important information to improve the psychometric properties of the IPI-II. The item analyses served to extend past research efforts to strictly define and translate Ely's (1990a) conditions into measurable factors (Bauder, 1993; Ely,

1999, 1990, 1976; Ensminger, 2005; Ensminger et al., 2004; Ravitz, 1999; Surry & Ensminger, 2002; Surry & Ely, 2001) and addressed several of the operationalized definitions that are open to interpretation and have caused confusion in certain populations as evidenced by the literature review.

Preliminary analysis. The preliminary analysis was conducted to obtain a comprehensive knowledge of the data and create a snapshot of the referent population for the current study. 352 university employees responded to the survey. Data cleaning resulted in a usable number of 252 responses. It was beyond the scope of this study to use multivariate analysis to explore relationships between the demographic variables. CFA is able to estimate latent traits separately from person traits for specific items and item properties in a sample (Brown, 2015). A variety of sources for the evidence used to evaluate the psychometric properties of an instrument are important to the development of a quality instrument.

Primary analyses. The primary analyses were completed to address the research goal of providing an evaluation of the psychometric properties of the IPI-II. SEM and CFA (a type of SEM) were utilized to obtain psychometric information to examine reliability and validity evidence for the IPI-II, a revised measure of Ely's conditions of change. To ensure thoroughness and clarity, the psychometric evaluation of the IPI-II was completed using confirmatory factor analysis on three alternative factor structure models for Ely's eight conditions. The models explored different fits of the 49 items to Ely's (1990a) eight conditions to Ensminger et al's (2004) four factors hypothesized to underlie Ely's eight conditions. Additionally, the 49 observable measures were subjected to further analysis at the item level. The results of these analyses were used to address the key research question and the three sub questions:

Research Question: What are the psychometric properties of the Implementation Profile Inventory II, a revised measure of Ely's conditions of change?

RQ1a: What psychometric information can be obtained from an analysis in which the four-factors hypothesized to underlie Ely's eight conditions were measured using 49 questionnaire items?

RQ1b: What psychometric information can be obtained from an analysis in which Ely's eight conditions were measured using 49 questionnaire items?

RQ1c: What psychometric information can be obtained from an analysis in which the four higher level factors and Ely's eight conditions were simultaneously measured using 49 questionnaire items?

Confirmatory factor analysis was the primary statistical technique used to obtain fit indices and parameter estimates for the alternative factor structure models for examination. A rigorous examination of the hypothesized four-factor structure (Ensminger et al., 2004) underlying Ely's eight conditions sought to address basic questions about the dimensionality of the IPI-II as measured by the 49 indicators. CFA provided evidence concerning the internal structure aspect of validity by testing if the responses to the 49 items fit the structure specified by the factor structure model (Furr & Bacharach, 2014).

Research question 1a. What psychometric information can be obtained from an analysis in which the four-factors hypothesized to underlie Ely's eight conditions were measured using 49 questionnaire items?

RQ1a was addressed by the fit statistics and parameter estimates for Model A (4 factors⇔49 items). Based on prior evidence and theory bearing on Ely's (1990a) eight conditions of change, a four-factor structure was specified by Ensminger and colleagues (2004) in which Leadership,

Commitment, and Dissatisfaction with Status Quo loaded onto the latent variable of Managed Change; Skills and Knowledge, Time, and Participation loaded onto the latent variable of Performance Efficacy; Incentives and Rewards loaded on the latent variable External Rewards; and, the condition Resources served as a latent variable in and of itself.

In fitting Model A to the sample data, parameter estimates and fit indices were evaluated. The fit indices for Model A indicated that what was expected to be observed from the results yielded by the IPI-II was a poor fit with what was actually observed with the data. Model A was the least flexible model, which was reflected by the poorer fit indices.

Model A's (4 factors⇔49 items) factor loadings for the items purporting to measure the two conditions, Resources and Rewards or Incentives, hypothesized to load on the higher-level factors Resources and External Rewards, were all moderate to strong, excepting Q16. The relatively large standardized factor loadings for Ely's two conditions, Resources and Rewards or Incentives, supported correlations showing that each indicator was at least moderately related to the respective underlying latent variables of Resources and External Rewards. The one exception, Q16, reads "Achieving a sense of personal satisfaction will make me more likely to use an innovation." and was purported to measure the condition Rewards or Incentives. However, its weak factor loading of 0.297 provided no information regarding how the presence of an external reward structure might serve to influence a respondent's decision to use a new technology.

The factor loadings for the items hypothesized to measure the condition, Dissatisfaction with the Status Quo were all too small, ranging from -0.61 to 0.07, to be useful in adequately describing the higher-level factor of Managed Change.

The psychometric information obtained from an analysis of Model A showed that data generated can be interpreted as indicating that only 80% of the questionnaire items accurately measured a respondent's perceptions of the importance of the higher level factors hypothesized to underlie Ely's eight conditions to their decision to implement a new technology.

Research question 1b. What psychometric information can be obtained from an analysis in which Ely's eight conditions were measured using 49 questionnaire items?

Model B (8 conditions⇔49 items) was a more flexible, better fitting model overall for the IPI-II in the sample of university faculty and staff. In fitting Model B to the sample data, parameter estimates and fit indices were evaluated. The fit indices for Model B indicated that what was expected to be observed from the results yielded by the IPI-II was a reasonable fit with what was actually observed with the data.

92% of the questionnaire items accurately measured a respondent's perceptions of the importance of Ely's eight conditions to their decision to implement a new technology. Only 4 of the 49 questions were shown to do a poor job of measuring a respondent's perception of those conditions. Those questions were Q1 Participation ("Trying to get input from those responsible for using an innovation won't have any effect on the innovation anyway" reverse coded), Q16 Rewards or incentives ("Achieving a sense of personal satisfaction will make me more likely to use an innovation"), Q20 Leadership ("Low and mid level managers who are opposed to an innovation can kill the innovation easily, even if upper level managers support it"), Q31 Dissatisfaction with Status Quo ("In my opinion, changes occur when people are unhappy with the current way things are done").

Research question 1c. What psychometric properties can be obtained from a CFA of Measurement Model C **(**4 factors⇔8 conditions⇔49 items) in which the four higher level factors and Ely's eight conditions were simultaneously measured using 49 questionnaire items?

In the process of thoroughly testing the hypothesized four-factor structure (Ensminger et al., 2004) in the current study, three alternative models were developed. CFA was utilized on measurement models A and B and SEM was employed for structural Model C (4 factors⇔8 conditions⇔49 items). The results of alternative Model C were most useful in providing completeness and validation for the hypothesized four-factor structure that emerged from the 2004 study by Ensminger and colleagues. SEM procedures provided a lens capable of viewing the big picture, showing the strength of the factor loadings of the 49 items on the eight conditions and then, most importantly illustrated the strength of the factor loadings of the eight conditions on the four higher-level factors; thus, allowing the researcher to conclude that the hypothesized four-factor model (Ensminger et al., 2004) provided a reasonable fit to the IPI-II responses.

Parameter estimates and fit indices indicated a good fit among seven of Ely's (1990a) eight conditions, confirming that Dissatisfaction with Status Quo does not load significantly on any higher-level factor. Model C parameter estimates were also important in revealing a potential modification, which would bring the model closer to the factor structure that truly underlies the relationships of the IPI-II's items to a higher order factor structure.

Model C most clearly illustrated the strong construct validity evidenced by the layer 1 factor loadings when constraining the items to load on Ely's eight conditions (Appendix D, Table D3). Most noteworthy, were the strong factor loadings for the items measuring Dissatisfaction with Status Quo in layer 1. In attempting to confirm that the condition, Dissatisfaction with Status Quo (DSS) can be interpreted to reflect a user's perception of how/if the factor Managed Change

influenced their responses to the items measuring DSS, the path analysis diagram (Figure 6) showed a pattern that disconfirms an underlying relationship among the items measuring DSS and the factor Managed Change.

Model C (4 factors⇔8 conditions⇔49 items) was the alternative factor structure model that promised to best support Ensminger et al.'s (2004) theorized four-factor structure for the IPI-II when Dissatisfaction with Status Quo was treated as a factor for assessing all eight of Ely's conditions. This alternative factor structure model showed how Ely's (1990a) conditions related to the four-factors conceptualized and named by Ensminger and colleagues (2004) when DSS was added to the higher level structure as a factor; thus, allowing the accurate measure of a respondent's complete "implementation profile" (Ensminger, et al, 2004, p. 69) with a five-factor structure.

Consistent with Models A and B, model C also revealed questionnaire items Q1, Q16, Q20, and Q31 to be poor measures of a respondent's perception respectively of Participation, Rewards or Incentives, Leadership, and Dissatisfaction with Status Quo. Consistent with Model A evaluation, the condition Dissatisfaction with Status Quo was shown to be uncorrelated with the factor Managed Change, revealing that how a respondent values upper level management's active role in the change process does not influence their response (endorsement) to the six items purported to measure Dissatisfaction with Status Quo (Q22, Q29, Q31, Q35, Q38, and Q39).

All three models were useful in providing construct validity evidence confirming the majority of the questionnaire items were measuring what was "implied by the theoretical basis of the intended construct" (Furr & Bacharach, 2014, p. 351). Parameter estimates from the three alternative factor structure models suggested the four-factor structure hypothesized by

Ensminger et al. (2004) was good, but could be better if Dissatisfaction with Status Quo was treated as a unique higher-level factor.

Key research question. What are the psychometric properties of the Implementation Profile Inventory II, a revised measure of Ely's conditions of change?

The key research question addressed fundamental psychometric issues related to reliability and the internal consistency of the IPI-II and the construct validity related to the internal structure of the IPI-II.

Coefficient alpha is a popular method of estimating reliability and the individual items' relationship to whole test reliability by identifying items to remove in an effort to increase test reliability. Additionally, item discrimination index was analyzed to identify the items that did a poor job of discriminating between individuals who strongly endorse an item and those who do not. This type of item analysis is the sine qua non for item selection, providing evidence used to inform decisions concerning items selected for modifications of an instrument (Hoyle, 2000).

Reliability. The IPI-II evidenced excellent internal consistency with a coefficient alpha of 0.9092. This internal consistency estimation procedure revealed five items to be potentially problematic in terms of reliability. Item analysis (Appendix J, Table J1) shows that the removal of DSS (Q38 and Q39), Rewards (Q44), Ldr (Q46), and Participation (Q1) would increase the reliability of the IPI-II.

Eight of the 49 items showed a poor ability to discriminate (Table J1) between respondents who strongly endorse an item and those who do not: Q31 (DSS), Q38 (DSS), Q39 (DSS), Q44 (Rewards), Q20 (Ldr), Q46 (Ldr), Q1 (Participation), and Q9 (Time). Five of the eight items with a weak discrimination index overlapped with those showing poor reliability. Again the

majority of the problem items were reverse coded during data preparation and should be considered for removal or revision.

Validity. In testing the hypothesized four-factor structure (Ensminger et al., 2004), CFA provided evidence of the internal-structure aspect of validity through correlation coefficients (Furr & Bacharach, 2014). Model A's (4 factors⇔49 items) correlation coefficients were least useful as validity evidence due to constraining the six items measuring Dissatisfaction with Status Quo to load on the factor Managed Change. However, if Model A factor loadings for those items were disregarded and the focus was on reliability, discrimination, and Model B (8 conditions⇔49 items) and C statistics, items Q31, Q38, and Q39 were still problematic.

The evidence obtained from testing models A, B, and C suggested that "Dissatisfaction with Status Quo", which governed the pattern of correlations between the items Q22, Q29, Q31. Q35, Q38, and Q39, was an important factor, in and of itself, when measuring perceptions of conditions of change. Appendix D contains the four tables presenting estimated standardized parameters for all items, conditions, and factors. Table I1 (Appendix I) presents the item response frequencies along with the most commonly reported statistics in an item analysis of item difficulty and the item discrimination. Table K1 (Appendix K) synthesizes the statistics necessary for respecifying the measurement models. The reliability and validity evidence gathered and represented in these tables provide guidelines for model respecification and instrument revision.

In addition to coefficient alpha, CFA can be used to estimate reliability; however, it is an iterative process that involves modifying the initial measurement model and again, testing the model for goodness-of-fit (Furr & Bacharach, 2014). The construct validity evidence developed by the CFA method identify potentially bad items by weak factor loadings. Items that show

weak correlation to the factor/s are removed and CFA is run again to determine if this provides a better fit.

Implications for the Implementation Profile Inventory II

The original IPI, first generation, has undergone more psychometric evaluation than any previous instrument used to assess Ely's eight conditions (Ensminger, 2005). The current study represents the first psychometric evaluation of the IPI-II and the first confirmatory study in the development cycle of the Implementation Profile Inventory. The CFA was conducted to assess the underlying factor structure of the measure; thus, addressing the need identified by Surry and Ensminger (2002; 2003) for an instrument specifically designed to measure the perceived importance of Ely's (1990a) eight conditions. When CFA is employed on an assessment tool, the results serve to provide greater empirical support for the developers' theoretical framework. Although the findings from the current study showed the IPI-II to have sound psychometric properties, there was evidence that the IPI-II would be better suited to a five-factor structure: Managed Change, Performance Efficacy, Resources, External Rewards, and Dissatisfaction with Status Quo.

Having a quality instrument whose psychometric properties have been rigorously examined takes instructional designers one step closer to the more interesting observation concerning the perception of the importance of Ely's (1990a) conditions and any causal relationship to the decision to implement a new technology. The ability to take a substantive, comprehensive, well-grounded theory of change and formalize it via a quantifiable model is an important step in the development of a tool useful to implementation planning. The ability to test the proposed casual relationships is what will allow instructional designers to go beyond describing the data and move into the arena of explaining the data.

The IPI-II is a revised instrument, in its first generation of development and there are expected issues with items and wording that need to be resolved. The validity evidence gathered in this confirmatory study could be useful in addressing items that do not show themselves to be good measures of the conditions and consequently poor measures of the higher order factors of Managed Change, Performance Efficacy, Resources, and External Rewards. Using this information to reduce the number of items is useful in validation efforts as redundancy and removal of bad items helps address a reduction in reliability based on attenuation (Strauss & Smith, 2009).

Most important was the opportunity to review the psychometric data, focused on the measures of Ely's (1990a) conditions of change and consider to what extent the empirical findings support the existence of a fifth distinct factor in the underlying structure of the IPI-II. The psychometric evidence developed in the current study may have taxonomic implications for Ely's framework and can serve to challenge the IDT field to further explore the nature and specific influences of conditions that influence the implementation of innovations.

Emergence of a five-factor measurement model. The results of the current study were consistent with the literature in the field concerning perceptions of Ely's (1990a) conditions and relationships among the conditions. Bauder (1993) found Dissatisfaction Status Quo to be ubiquitous, but never the most important condition to K-12 teachers in their decision to use computers. Ravitiz's (1999) results showed Dissatisfaction with Status Quo to be one of only two conditions consistently having the strongest correlation to the decision to use the internet. Ensminger's (2005) statistical analysis of the IPI showed Dissatisfaction with Status Quo to have the highest grand mean and to be the most important condition across all groups in his study. Additionally, the results confirmed Ensminger et al.'s (2004) analysis based on their decision to

exclude Dissatisfaction with Status Quo due to a double-factor loading on Managed Change and External Rewards. However, further consideration should be given to reconceptualizing the condition Dissatisfaction with Status Quo, revisiting the indicator measures for this condition, and elevating this condition to a higher-level factor.

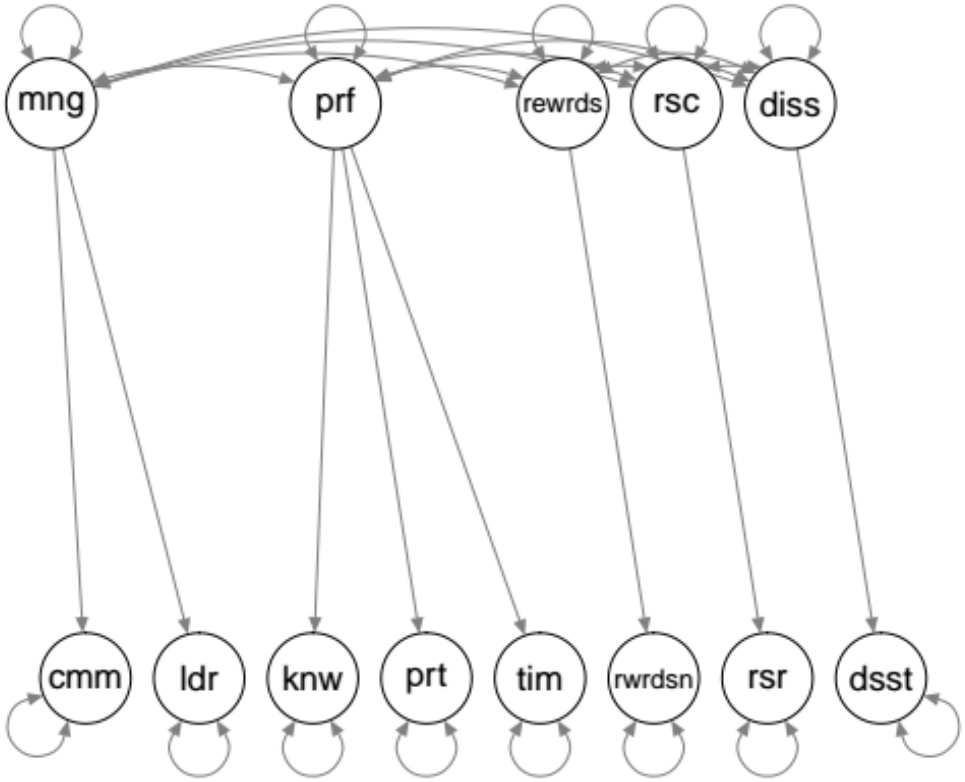

Figure 8. The hypothesized five-factor structure model. Diagram abbreviations include: mng = managed change, prf = performance efficacy, rewrds = external rewards, rsc = resources, diss=dissatisfaction with Status Quo, cmm = commitment, ldr = leadership, knw = skills and knowledge, prt = participation, tim = time, rwrdsn = rewards and incentives, dsst = dissatisfaction with status quo.

Considerations for model modifications. The model may be improved by expanding the number of higher-level factors from four to five and reconceptualizing the fifth factor labeled to address the construct of Dissatisfaction with Status Quo. The measurement model for the IPI-II may further be improved by simplifying the number of items measuring each condition. The IPI-II currently has six items measuring each condition (except for Resources, which has seven).

The data supported reducing the number of metrics per factor from six to four. IPI-II items that were shown to negatively impact the reliability should be considered for removal, along with the items showing poor discrimination and weak factor loadings. Table I1 in Appendix I was created to serve as a guide for model respecification and instrument revisions.

A model fit is considered to be "testable" (not statistically testable) with four items (Hoffman, 2014) per factor. Lastly, instead of having a 7-point Likert scale for responses, consider a 5-point scale. In the long run, research may be better served by a scale of lower but acceptable reliability with fewer items and less redundancy. When focusing the attention on measurement model respecification, the research is no longer confirmatory in nature. Models that are developed through analysis are viewed as "data-driven exploratory model fitting" (Segars & Grover, 1993, p. 521) and can no longer be tested "with any degree of validity" (p. 521) and should be cross-validated with an independent dataset.

Contributions to the Field of Instructional Design and Technology

Ely (1990a) concluded this article with prophetic words of warning that "…the decades to come might rewrite the conditions in light of the changing times in which we live" (p. 304).

Incentives and Rewards is an original condition that Ely (1978) initially labeled "reward for effort" and made no distinction between 'intrinsic' and 'extrinsic' rewards. He does not address this condition from the organizational perspective, but frames his description of what constitutes a reward as dependent on the role of the individual within the organization. In 1978, all of Ely's work was in university libraries with librarians. As Ely (1990a; 1999a) moved towards a more generalizable framework, validated cross-culturally, he expanded the condition to address 'extrinsic' and 'intrinsic' rewards and relabeled the condition *Rewards or Incentives*.

As Ely worked towards a more generalized framework, he noted that Rewards and Incentives was a condition that was present in some form across cultures, but was never endorsed as one of the more important conditions. Ely felt that an incentive was associated with an expectation of a reward or a fear of punishment. He felt that a reward was something that was attached to an action that results in a job well done. Ely (1990a) reconceptualized the construct and further refined the condition in his 1999 article (Appendix A). However, he admits that the inability to endorse this condition could be a function of misinterpretation and confusion with the condition, Dissatisfaction with Status Quo.

Bauder (1993) noted that perceptions of Dissatisfaction with Status Quo and Incentives and Rewards were highly dependent on the structure of the organization and that intrinsic rewards were often assumed to be sufficient motivation to implement a new technology. Ravitz (1999) felt strongly that Dissatisfaction with Status Quo and Incentives and Rewards were two conditions that needed to be reconceptualized based on the results of his study. Primarily, he felt the extremely strong correlations between items conceptualized to measure intrinsic rewards and incentives were viewed as representing Dissatisfaction with Status Quo. Ravitz felt that the condition Incentives and Rewards should be operationalized to represent a distinct factor representing *extrinsic* rewards only. Ensminger et al. (2004) addressed this conflict by conceptualizing and naming External Rewards as a higher-level factor. Ensminger and colleagues operationalized this factor by reversing the meaning of the factor and interpreting low scores (not endorsing the item or selecting disagree) as representing individuals who expect to be incentivized before making the decision to implement a new technology.

Revisiting and refining Ely's (1990a) eight conditions. Based on results of the current study, next steps in research should focus on the eight conditions which influence

implementation of educational technology innovations, clarify them and seek their antecedents and correlates as evidenced in developments in 21st century working environments in higher education, K-12, the corporate world, and non governmental organizations.

Multiple studies (Bauder, 1993; Brown, 2008; Ensminger et al., 2004; Ravitz, 1999) indicated the complex relationship Dissatisfaction with Status Quo (DSS) presented as regards Ely's conceptual framework. Ely (1976, 1990, 1999) himself struggled with operationalizing this condition as was evidenced in his original seven conditions (Appendix C) and the evolution of how he operationalized DSS over time (Appendix A). Ely identified DSS as the only condition associated with an emotion, a feeling. Ely identified DSS as always present as an influencer, but never the most important condition regardless of the culture or organization. Ely also consistently linked DSS with the condition Leadership.

In Bauder's (1993) study of the relationship between computer use and Ely's eight conditions in a K-12 environment, her main finding concerning DSS was that it was one of only two conditions (the other condition was Rewards and Incentives) that showed no significant difference in perceptions between computer users and non-computer users. Ravitz (1999) also identified DSS and Incentives and Rewards as sources of potential confusion. In his 1999 study, Ravitz chose to reconceptualize DSS as representing the "perceived utility" of the innovation and he limited the condition Incentives and Rewards to address "extrinsic" rewards only. Brown (2008) suggested that DSS could be analyzed in terms of the innovation's attributes, very much along the lines of the Technology Acceptance Model's view of ease of use (Davis, 1985).

Research in this area showed fairly good agreement concerning the number of conditions in Ely's framework, but there was less accord with respect to their strength and operationalization. "One could speculate on the reasons for the strengths and weaknesses of the conditions but this

analysis is best saved for another paper " (Ely, 1990b, p. 7/8). Given the strong undercurrent of confusion surrounding the condition of Dissatisfaction with Status Quo in the current study that was also present in Bauder, Ravitz, and Ely's previous research, there should be more exploration of what actually constitutes this latent trait and how it influences perceptions of conditions that facilitate implementation of a new technology.

In addition to rigorous confirmatory factor analyses that tested Ensminger et al.'s (2004) hypothesized four-factor structure of a revised instrument, the current study also tested three alternative factor structure models that provided more evidence for alternative structures (4⇔8⇔49 and even 5⇔8⇔49) for the IPI-II. The current study made an important contribution to the field by extending Surry and Ensminger's previous research (2002; 2004; 2005) on developing an instrument to measure perceptions of Ely' (1990a) eight conditions and providing an evaluation of the psychometric properties of the IPI-II, an instrument not previously used in research. As was described in the study introduction and the review of the literature, there is a need for reliable and accurate instruments to assess conditions of change along with a need for studies confirming exploratively derived factor structures.

Limitations

There were limitations to the study that were inherent to the methodology. A modified scale cannot be assumed to have the same psychometric qualities of the original scale (Furr, 2011). The hypothesized four-factor structure resulted from an EFA on the original IPI with a different set of observations, and "factor structures obtained by exploratory factor analysis (EFA) often turn out to fit poorly in confirmative follow-up studies" (Van Prooijen & Van Der Kloot, 2001, p. 777). There are three methodological explanations for differences between EFA and CFA

findings: (a) inappropriate applications of EFA, (b) incomparability of EFA and CFA, and (c) inappropriate applications of CFA (Van Prooijen & Van Der Kloot, 2001).

There are no standards providing guidelines for what is reported in CFA studies (Jackson, Gillaspy & Purc-Stephenson, 2009). In an attempt to develop a comprehensive grasp of CFA reporting practices in the social sciences, Jackson et al. (2009) noted that most often studies were incomplete in reporting parameter estimates, not detailed enough with justification and specifications for models tested, in addition to overgeneralization of findings. Every attempt was made to report all data relevant to the central question in the current study. The complete factor analysis report files are available as supplemental electronic materials. Information on how to access the full report along with the original R Markdown format is available in Appendix L.

Recommendations for Future Research

Decades of research by Surry and Ensminger resulted in the conclusion that the IDT field could benefit from the ability to assess a user's perceptions of the importance of Ely's (1990a) eight conditions of change. Although, the findings from the current study supported the hypothesized four-factor structure and presented some initial concurrent validity data, a potentially better fitting five-factor model was identified and has yet to be assessed.

The underlying factor structure of the IPI-II may be improved by expanding the number of higher-level factors from four to five and reconceptualizing the fifth factor labeled to address the construct of Dissatisfaction with Status Quo. The measurement model for the IPI-II may further be improved by simplifying the number of items measuring each condition. The IPI-II currently has six items measuring each condition (except for Resources, which has seven). The data supported reducing the number of metrics per factor from six to four. IPI-II items that were shown to negatively impact the reliability should be considered for removal, along with the items

showing poor discrimination and weak factor loadings. Table K1 (Appendix K) was created to facilitate the process of developing a new set of indicator measures to achieve a stable, well-defined solution for the structure of the IPI-II. A model fit is considered to be testable with four items (Hoffman, 2014) per factor. Lastly, instead of having a 7-point Likert scale for responses, consider a 5-point scale. In the long run, research may be better served by a scale of lower but acceptable reliability with fewer items and less redundancy.

At this stage in the development cycle of the IPI-II, the next potential step is model respecification and reanalysis with the goal of improving our understanding of Ely's (1990a) eight conditions and the underlying factor structure of the IPI-II. Caution regarding modifications in a CFA include awareness of the number of modifications, confidence that the modifications have a clear conceptual basis, and a cross-validation sample to rule out any response pattern that may be idiosyncratic to the dataset (Furr & Bacharach, 2014; Segars & Grover, 1993).

As would be expected, the process of validation may not only lead to revisions in the instrument, but also lead to changes in the conceptual framework the instrument is based on. Any results from the revised instrument would again need validation (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014).

This study furnished reliability and validity evidence and an expanded rationale in support of the use of the IPI-II as a tool that provides a comprehensive assessment of the conditions that influence implementation which will lead to the development of effective implementation strategies tailored to individuals and organizations (Ensminger, 2005).

Summary

Findings from the current study offered initial enthusiasm for the IPI-II as a measure that assesses the constructs corresponding to Ely's (1990a) eight conditions of change with a hypothesized four-factor structure (Ensminger et al., 2004). However, the results tentatively support an emergent five-factor structure model as a more adequate fit to the data. The validity evidence gathered and analyzed served as a step in the validation of Dissatisfaction with Status Quo as a fifth factor.

The first key question that arose in the original IPI study (Ensminger et al., 2004) "Are the factors discovered in this study consistent?" (p. 69) was answered by this study with a qualified yes. The current study was not the proposed replication of the 2004 study, but arguably served as a conceptual replication of the 2004 study.

Does a five-factor model serve to over identify the underlying relationship between Ely's (1990a) eight conditions or can the five-factor model serve as the grand unifying structure regarding Ely's theory of change and the conditions that support change and influence the decision to implement a new technology? Further work will no doubt bring change and clarification. Nonetheless, it is hoped that the outcomes of the confirmatory factor analysis method will bring clarity to the puzzling relationship between conditions of change and implementation of an innovation, providing the IDT community with a valuable measure serving to explain conditions that facilitate the implementation of educational technology innovations.

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References

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (2014). *Standards for educational and psychological testing.* Washington, DC: American Educational Research Association.

Babbie, E. R., Halley, F., & Zaino, J. (2007). *Adventures in social research: Data analysis using SPSS 14.0 and 15.0 for windows* (6th ed.). Thousand Oaks: Pine Forge Press, an Imprint of Sage Publications.

Bauder, D. Y. (1993). *Computer integration in K-12 schools: Conditions related to adoption and implementation* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (Order No. 9401653)

Beaujean, A. A. (2014). Latent variable modeling using R: A step-by-step guide. New York: Routledge.

Berman, P. (1981). Educational change: An implementation paradigm. Improving Schools: *Using what we Know*, 253–286.

Berman, P. & McLaughlin, M. W. (1976). Implementation of educational innovation. *The Educational Forum, 40*(3), 345–370. doi:10.1080/00131727609336469

Boomsma, A., Janke C. ten Holt, & Marijtje A. J. van Duijn. (2010). Scale construction and evaluation in practice: A review of factor analysis versus item response theory applications. *Psychological Test and Assessment Modeling*, 52(3), 272-297.

Brown, J. A. (2008). Perceptions of the relative importance of conditions that facilitate implementation (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. DP19406)

Brown, T. A. (2015). *Confirmatory factor analysis for applied research*. The Guilford Press.

Buchanan, T., Sainter, P., & Saunders, G. (2013). Factors affecting faculty use of learning technologies: Implications for models of technology adoption. *Journal of Computing in Higher Education, 25*(1), 1–11.

Burkman, E. (1987). Factors affecting utilization. *Instructional Technology: Foundations,* 429–456.

Byrne, B. M. (2012). *A primer of LISREL: Basic applications and programming for confirmatory factor analytic models.* Springer Science & Business Media.

Carlopio, J. (2003). *Changing gears: The strategic implementation of technology*. New York: Palgrave Macmillan.

Cole, D. A. (1987). Utility of confirmatory factor analysis in test validation research. *Journal of Consulting and Clinical Psychology, 55*(4), 584.

Comrey, A. L., & Lee, H. B. (1992). *A first course in factor analysis* (2nd ed.). Hillsdale, N.J: L. Erlbaum Associates.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, Calif: Sage Publications.

Davis Jr, F. D. (1985). A technology acceptance model for empirically testing new end-user information systems: Theory and results (Doctoral dissertation). Retrieved from Massachusetts Institute of Technology.

DeFleur, M. L. (1966). *Theories of mass communication*. New York: David McKay Company.

DeVellis, R. F. (1991). *Scale development: Theory and applications.* Newbury Park, Calif: Sage.

DiStefano, C., Zhu, M., & Mindrila, D. (2009). Understanding and using factor scores: Considerations for the applied researcher. *Practical Assessment, Research & Evaluation, 14*(20), 1–11.

Doll, W. J., Xia, W., & Torkzadeh, G. (1994). A confirmatory factor analysis of the end-user computing satisfaction instrument. *MIS Quarterly,* 18(4), 453–461.

Dooley, K. E. (1999). Towards a holistic model for the diffusion of educational technologies: An integrative review of educational innovation studies. *Educational Technology & Society, 2*(4), 35–45.

Ellsworth, J.B., IV. (1990). *Factors affecting participant reactions to new training devices* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 9903405).

Ellsworth, J. B. (2000). *Surviving change: A survey of educational change models*. New York: ERIC Clearinghouse on Information & Technology. (ED443417)

Ely, D. P. (1990a). Conditions that facilitate the implementation of educational technology innovations. *Journal of Research on Computing in Education, 23*(2), 298–305. Doi: 10.1080/08886504.1990.10781963

Ely, D. P. (1978). Creating the conditions for change. In Fabisoff, S. & Bonn. G., (Eds), *Changing times: Changing libraries (pp. 150–162). Champaign, IL: University of Illinois Graduate Library School.*

Ely, D. P. (1990b). *The diffusion and implementation of educational technology in developing nations: Cross-cultural comparison of Indonesia, Chile and Peru*. New York: ERIC Clearinghouse on Information Resources. (ED331469)

Ely, D.P., & Plomp, T. (1996). *Classic writings on instructional technology* (Vol 1). Libraries Unlimited.

Ely, D. P. (1999a). Conditions that facilitate the implementation of educational technology innovations. *Educational Technology*, 39(6), 23–27.

Ely, D. P. (1999b). *New perspectives on the implementation of educational technology innovations*. New York: ERIC Clearinghouse on Information Resources. (ED427775)

Ensminger, D. C. (2001). *Using Ely's conditions during the instructional design process to increase success of implementation*. Paper presented at the proceedings of DESIGN: Connect Create Collaborate Conference, Athens, GA. (pp. 49–54).

Ensminger, D.C., & Surry, D.W. (2002). *Faculty perceptions of factors that facilitate the implementation of online programs*. Retrieved from ERIC database. (ED464622)

Ensminger, D. C., Surry, D. W., Porter, B. E., & Wright, D. (2004). Factors contributing to the successful implementation of technology innovations. *Educational Technology & Society, 7*(3), 61–72.

Ensminger, D. C. (2005). *The conditions that facilitate the implementation of technology and process innovations: A comparison of K--12, higher education, and business/industry using the implementation profile inventory* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (UMI No. 3163174)

Epskamp, S. (2015). semPlot: Unified visualizations of structural equation models. *Structural Equation Modeling: A Multidisciplinary Journal, 22*(3), 474–483.

Eraut, M. (1975). Promoting innovation in teaching and learning: Problems, processes and institutional mechanisms. *Higher Education, 4*(1), 13–26.

Fava, J. L., & Velicer, W. F. (1996). The effects of underextraction in factor and component analyses. *Educational and Psychological Measurement, 56*(6), 907–929.

Fowler, F. J. (2002). Survey research methods (3rd ed.). Thousand Oaks, Calif: Sage Publications.

Fullan, M., & Pomfret, A. (1977). Research on curriculum and instruction implementation. *Review of Educational Research, 47*(2), 335–397. doi:10.2307/1170134

Fullan, M. (1982). The meaning of educational change. New York: Teachers College, Columbia University.

Fullan, M., & Stiegelbauer, S. (1991). The new meaning of change. New York: Teachers College Press.

Furr, M. R. (2011). *Scale construction and psychometrics for social and personality psychology*. London; Los Angeles: SAGE.

Furr, R. M., & Bacharach, V. R. (2013). Psychometrics: an introduction. Sage.

Gagne, R., Briggs, L., & Wager, W. W. (1988). *Principles of instructional design.* New York: Holt, Rinehart and Winston.

Gerbing, D. W., & Hamilton, J. G. (1996). Viability of exploratory factor analysis as a precursor to confirmatory factor analysis. *Structural Equation Modeling: A Multidisciplinary Journal, 3*(1), 62–72.

Giles, D. (2002). Advanced research methods in psychology. New York; Hove, East Sussex: Routledge.

Gorsuch, R. L. (1990). Common factor analysis versus component analysis: Some well and little known facts. *Multivariate Behavioral Research, 25*(1), 33–39.

Hall, G., Wallace, R., & Dossett, W. (1973). A developmental conception of the adoption process within educational institutions (report no. 3006). Austin, TX: The University of Texas at Austin. *Research and Development Center for Teacher Education.*

Hall, G. E. (1974). The concerns-based adoption model: A developmental conceptualization of the adoption process within educational institutions. Austin, TX: University of Texas. Retrieved from ERIC database. (ED111791)

Hall, G. E., & Loucks, S. F. (1977). A developmental model for determining whether the treatment is actually implemented. *American Educational Research Journal, 14*(3), 263–276.

Hall, G. E., & Hord, S. M. (1987). *Change in schools: Facilitating the process*. Albany, NY: State University of New York Press.

Hall, G. E., & Hord, S. M. (2011). Implementation: Learning builds the bridge between research and practice. *Journal of Staff Development, 32*(4), 52–57.

Harrington, D. (2009;2008;). Confirmatory factor analysis. Oxford; New York: Oxford University Press. doi:10.1093/acprof:oso/9780195339888.001.0001

Haryono, A. (1990). *Lecturer's perceptions of the conditions that facilitate the adoption and implementation of an instructional innovation introduced through a training program in*

higher education in indonesia (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses. (Order No. 9126117)

Havelock, R. G. (1973). *The change agent's guide to innovation in education*. Englewood Cliffs, N.J: Educational Technology Publications.

Havelock, R. G., & Huberman, A. M. (1977). Solving educational problems: The theory and reality of innovation in developing countries. Paris: Unesco.

Hj Nawawi, Mokhtar B Dato'. (2005). *Conditions facilitating utilization of instructional technology in higher education: A study of universiti putra malaysia,* Malaysia (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (UMI No. 3186476)

Hoyle, R. H. (2000). Confirmatory factor analysis. In H. Tinseley, S. Brown, & I. Ebrary (Eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modeling* (pp. 465-497). San Diego: Academic Press.

Jackson, D. L., Gillaspy Jr, J. A., & Purc-Stephenson, R. (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological Methods, 14*(1), 6.

Jeffery, J. A. (1993). *Conditions in schools that facilitate implementation of peer coaching* (Doctoral dissertation). Retrieved from Syracuse University, ProQuest Dissertations Publishing. (Order No. 9401685)

Jones, L. V., & Thissen, D. (2007). A history and overview of psychometrics. *Handbook of Statistics, 26*, 1-28. Doi: 10.1016/S0169-7161(06)26001-2

Kane, M. T. (2001). Current concerns in validity theory. *Journal of Educational Measurement, 38*(4), 319–342.

Lavrakas, P. J. (2008). *Encyclopedia of survey research methods* (illustrat annotate ed.). Thousand Oaks, Calif: Sage Publications.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods, 4*(1), 84.

Marovitz, M. E. (1994). *The diffusion of educational television at the united states military academy. Retrieved from Syracuse University, ProQuest Dissertations Publishing. (Order No. 943394)*

Marsh, H. W., & Bailey, M. (1991). Confirmatory factor analyses of multitrait-multimethod data: A comparison of alternative models. Applied Psychological Measurement, 15(1), 47–70. doi:10.1177/014662169101500106

Mayhew, L. B. (1976). How colleges change: Approaches to academic reform. Retrieved from ERIC database. (ED125607)

Meyer, J. P. (2014). *Applied measurement with jMetrik.* New York: Routledge.

Mokkink, L. B., Terwee, C. B., Knol, D. L., Stratford, P. W., Alonso, J., Patrick, D. L., . . . Vet, d., H.C.W. (2010). The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: A clarification of its content. BMC Medical Research Methodology, 10(1), 22-22. doi:10.1186/1471-2288-10-22

Murphy, M. T. (2015). *Perceptions of the influence of ely's conditions for the implementation of educational technology: A study within community college settings* (Doctoral Dissertation*)*. Retrieved from ProQuest Dissertations and Theses.

Osterlind, S. J. (2006). *Modern measurement: Theory, principles, and applications of mental appraisal*. Upper Saddle River, N.J.: Pearson/Merrill Prentice Hall.

Pedhazur, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis: An integrated approach*. Hillsdale, N.J: Lawrence Erlbaum Associates.

Pett, M. A., Lackey, N. R., & Sullivan, J. J. (2003). *Making sense of factor analysis: The use of factor analysis for instrument development in health care research*. Thousand Oaks, Calif: Sage Publications.

Ravitz, J. L. (1999). *Conditions that facilitate teacher internet use in schools with high internet connectivity: A national survey* (Doctoral dissertation*)*. Retrieved from ProQuest Dissertations and Theses. (UMI No. 9925992)

Read, C. E. (1994). *Conditions that facilitate the use of shared decision-making in school* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (Order No. 9434003)

Redli, D. (2015). *Comparison of ipsative and normative measures from the perspective of their psychometric properties* (Doctoral dissertation*)*. Brno, Czech Republic. Retrieved from http://is.muni.cz/th/382665/ff_m/Diploma_thesis_Comparison_of_ipsative_and_normative_measures_from_the_perspective_of_their_psychometric_properties.pdf

Reise, S. P., Waller, N. G., & Comrey, A. L. (2000). Factor analysis and scale revision. *Psychological Assessment, 12*(3), 287.

Reiser, R. A., & Dempsey, J. V. (2012). *Trends and issues in instructional design and technology* (3rd ed.). Boston: Pearson.

Riley, M. E. (1995). *Conditions that facilitate implementation of a career development program to promote gender equity in middle and junior high schools* (Doctoral dissertation). Available from ProQuest Dissertations & Theses Global. (UMI No. 9544945)

Rogers, E. M. (1962). *Diffusion of innovations*. New York: Free Press.

Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of innovations: A cross-cultural approach* (2nd ed.). New York: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Rogers, E. M. (2004). A prospective and retrospective look at the diffusion model. *Journal of Health Communication, 9*(S1), 13–19.

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36.

Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on rogers' theory. *TOJET: The Turkish Online Journal of Educational Technology, 5*(2).

Schön, D. A. (1967). *Technology and change: The new Heraclitus*. New York: Delacorte Press.

Segars, A. H., & Grover, V. (1993). Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. MIS quarterly, 517-525.

Statistics Solutions. (2013). Confirmatory factor analysis. Retrieved from http://www.statisticssolutions.com/academic-solutions/resources/directory-of-statistical-analyses/confirmatory-factor-analysis/

Stein, D. R. F. (1997). *Conditions that facilitate the implementation of innovative freshman experience courses: A comparative analysis of three courses* (Doctoral dissertation). (UMI No. 9820360)

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). New York: Routledge.

Straub, E. T. (2009). Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research, 79*(2), 625-649. doi:10.3102/0034654308325896

Strauss, M. E., & Smith, G. T. (2009). Construct validity: Advances in theory and methodology. *Annual Review of Clinical Psychology, 5*, 1.

Stuart, W. D. (2000). *Influence of sources of communication, user characteristics and innovation characteristics on adoption of a communication technology* (Doctoral dissertation). (UMI No. 9998115)

Surry, D. W., & Farquhar, J. D. (1997). Diffusion theory and instructional technology. *Journal of Instructional Science and Technology, 2*(1), 24-36.

Surry, D. W., & Ensminger, D. C. (2002, April). Perceived importance of conditions that facilitate implementation. In *Annual Meeting of the American Educational Research Association, New Orleans, LA*

Surry, D. W., & Ely, D. P. (2002). Adoption, diffusion, implementation, and institutionalization of educational technology. In R. Reiser, & J. Dempsey (Eds.), *Trends and Issues in*

Instructional Design and Technology (pp. 183-193). Upper Saddle River, J.J.: Merrill/Prentice Hall.

Surry, D. W., & Ensminger, D. C. (2004). Development of implementation profile instrument. *British Journal of Educational Technology, 35*(4), 503-504. doi:10.1111/j.0007-1013.2004.00408.x

Surry, D. W., Ensminger, D. C., & Haab, M. (2005). A model for integrating instructional technology into higher education. *British Journal of Educational Technology, 36*(2), 327–329.

Surry, D. W., Jackson, K., Porter, B. E., & Ensminger, D. (2006). *An analysis of the relative importance of ely's eight implementation conditions*. New York: ERIC Clearinghouse on Information Resources. (ED491620)

Surry, D. W., & Ensminger, D. C. (2008). Relative ranking of conditions that facilitate innovation implementation in the USA. *Australasian Journal of Educational Technology, 24*(5), 611–626.

Surry, D. W., Grubb, A. G., Ensminger, D. C., & Ouimette, J. (2009). Implementation of web-based learning in colleges of education: Barriers and enablers. *Canadian Journal of Learning and Technology, 35*(3), 1.

Tessmer, M. (1990). Environmental analysis: A neglected stage of instructional design. *Educational Technology Research and Development, 38*(1), 55.

Van Prooijen, J., & Van Der Kloot, W. (2001). Confirmatory analysis of exploratively obtained factor structures. *Educational and Psychological Measurement, 61*(5), 777-792.

Varden, C. H. (2002). *Application of ely's conditions in implementation of a wireless laptop program* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses Global. (UMI No. 3040757)

Zaltman, G., & Duncan, R. (1977). *Strategies for planned change*. New York: Wiley.

Zaltman, G., Duncan, R., & Holbek, J. (1973). *Innovations and organizations*. Wiley New York.

Zimmerman, B. J., & Schunk, D. H. (2014). *Educational psychology: A century of contributions: A project of division 15 (educational psychology) of the American Psychological Society*. New York: Routledge.

Appendices

Appendix A

Ely's Conditions that Facilitate the Implementation of Educational Technology Innovations and their Change Over Time

Conditions that Facilitate the Implementation of Educational Technology Innovations

Condition	1990	1999
1. Dissatisfaction with the Status Quo	Something is not right. Things could be better. Others are moving ahead; we are standing still. There must be something we can do to improve. One of the first steps to initiate change in an education environment is dissatisfaction with things as they are. It usually is observed in classroom problems that cannot be solved, for example, too many students, poor performance on examinations. It may come from teachers who are not motivated (for whatever reason) to consider change in their teaching procedures. The dissatisfaction can come from the school principal or from parents. It is usually expressed by individuals who want to bring about changes but do not know where to begin. Some researchers referred to needs for improvement (Fullan, 1982; Verspoor, 1989), and others simple speak of the necessity to change (Miles, Ekholm, & Van den Burghe, 1987).	Something is not right. Things could be better. Others are moving ahead; we are standing still. There must be something we can do to improve out situation. Whether the dissatisfaction is an innate feeling or an induced state (as brought about by marketing campaigns, for example), it is an emotion that calls for change. In most of the studies, this condition was not the most important factor in bringing about implementation, but it was generally agreed that it has a place in the mix of conditions.
2. Knowledge and Skills	The people who will	The knowledge and skills are

Exist/Existence of knowledge and skills	ultimately implement any innovation must possess sufficient knowledge and skills to do the job. This factor is often called "competence" (Verspoor, 1989). People may believe that changes are in order, but without the specific knowledge and skills to bring about the change the individual is helpless. In the case of microcomputers in education, a teacher must possess the competencies to teach students the use of these tools. (There are stories, however, of students teaching teachers to use micros. Such teachers must have strong ego-strengths.) Knowledge and skills can be acquired in many ways: in-service courses, self-instructional programs, tutorial assistance, and formal education (Janssen-Reinin, 1989). The basic fact is the knowledge and skills must be present for change to occur.	those required by the ultimate user of the innovation. It seems evident that such a condition should be in the list and, indeed, it was consistently near the top of the list as one of the most important factors leading to implementation.
3. Resources are Available/Availability of resources	The things that are needed to make the innovation work should be easily accessible. This condition is probably most self-evident of all. Without the hardware and software, it is almost impossible to implement changes that require such support materials (Chapman, 1990; Fullan, 1982). Resources are broadly defined as those tools and other relevant materials that are accessible to assist learners to acquire learning objectives.	This condition refers to the things that are required to make implementation work. It includes hardware, software, publications, audiovisual media, and other teaching materials. Reference to funding in general is also an indicator of the money required to obtain these resources. Other examples are access to a copy machine, clerical help, and instructional supplies.

	Materials must not always be expensive devices; they can be as simple as paper and pencils supplied to children in an African school or bottle caps and stones that are used to practice counting.	
4. Time is Available/Availability of time	Good time. Company time. Paid time. Implementors must have time to learn, adapt, integrate, and reflect on what they are doing. Time is often considered to be a resource, and indeed it is. However, in the process of educational change, time should be considered as a distinct condition that must be made available for implementation to occur (Verspoor, 1989). Teachers need time for in-service training; they need time to revise existing teaching plans; they need time to practice with new materials; they need time to try out and evaluate new teaching procedures. In short, time is a vital element in the total process of educational change.	Implementors need time to acquire knowledge and skills, plan for use, and adapt, integrate, and reflect upon what they are doing. This means good time, "company" time, paid time arranged for by the organization where the innovation will be implemented. It sometimes means the willingness of individuals to contribute some of their own personal time to the process.
5. Rewards or Incentives Exist for Participants/Rewards or incentives exist	For some it may mean satisfaction for a job well done; for others it may mean more assistance, more (or better) resources, and in some cases, increased salaries and professional opportunities. Why should anyone change? If current practice is going reasonable well, why risk new techniques? The potential for failure is there when new procedures are followed. There must be sufficient	The studies discovered a minor conflict between the words "reward" and "incentive." An incentive is something that serves as an *expectation* of a reward or fear of punishment. It serves as a stimulus to move an individual to action. A reward is something given for performance—an action that demonstrates satisfaction with a job well done. The complication is extended by

	reason to consider change and that is where incentives plan an important role (Miles, Ekholm, & Van den Burghe, 1987). Incentives vary for individuals. For some it may be new and more teaching materials, for others it may be personnel assistance—an assistant or secretarial help, while some people are satisfied by new experiences that offer relief from current routines. Whatever the reward, intrinsic or extrinsic, it should be there in some form.	the difference between an *extrinsic* reward and an *intrinsic* reward. Extrinsic rewards can be observed; intrinsic rewards are internal to the individual. It is difficult to measure the "satisfaction" that may be felt by users of the innovation. It may be that the potential conflicts in interpretation of rewards and incentives led to less importance of this factor in most of the studies. Even though the condition was present in all of the studies, it was reported to be of lesser importance.
6. Participation is Expected and Encouraged/Participation	This means shared decision-making, communication among all parties involved, and representation where individual participation is difficult. It seems obvious that individuals should be involved in decisions that directly affect their lives. However, in education, decisions are often made by others and handed down for implementation. Policies may be one thing, but practices are another. Unless the individual who is expected to implement the change has some part in deciding what to do, it is unlikely that the innovation will be implemented with fidelity and enthusiasm (Fullan, 1982). Participation may occur at many levels: during problem identification, during consideration of alternative solutions, and during decision making when	This is another ambiguous term that may have caused some variation in interpretation. However, it was confirmed as an important factor in all of the studies. Participation means shared decision-making, and communication among all parties involved in the process. When direct participation is not possible, the implementors should feel that their ideas are represented through a surrogate. Participation was often reported as a strong condition.

	new programs or approaches are adopted. Sometimes individuals can be represented by trusted colleagues since it is not possible to participate in every decision-making event. The important message here is that each person feels that he or she has had an opportunity to comment on innovations that will directly affect his or her work.	
7. Commitment by Those Who are Involved/Commitment	An unqualified go-ahead and vocal support for the innovation by key players and other stakeholders is necessary. Commitment occurs at all levels. A first commitment, initiated from an internal or external source, is probably made by a chief administrative officer. It should be endorsed after those who will be affected have had an opportunity to consider it and provide input. Commitment communicates support, and any individual who is about to try a new material or procedure wants to know that there is support from a higher level (Chapman, 1990). This is not blind commitment, but firm and visible evidence that there is endorsement and continuing support for implementation.	This condition demonstrates firm visible evidence that there is endorsement and continuing support for implementation of the innovation. This factor may be expressed by the primary leader (a principal of a school, for example) or a group, such as a board of directors. This condition is usually measured by the perceptions of the implementors, rather than public acknowledgment of policy.
8. Leadership is Evident/Leadership	Two-pronged leadership is necessary: (a) by the executive officer of the organization and (b) by the project leader who is more closely involved in day-to-day activities. Even though	Leadership, in this case, is two-pronged: (1) leadership of the executive officer of the organization, and sometimes of a board, and (2) project leadership, which is more closely related to the day-to-

	individuals act alone, especially in classroom endeavors, they need the inspiration and continuing support of individuals whom they respect. These individuals, often called leaders, provide initial encouragement to consider new ideas; they insure that the necessary training is given and that the materials to do the job are easily available; they are available for consultation when discouragement or failure occur; and they continually communicate their enthusiasm for the work at hand. Leaders should be easily identified (Havelock & Huberman, 1978).	day activities of the innovation being implemented. Once the executive leadership is evident, then the project leadership becomes even more important because the person who can help with the implementation is closer to the user.

Appendix B

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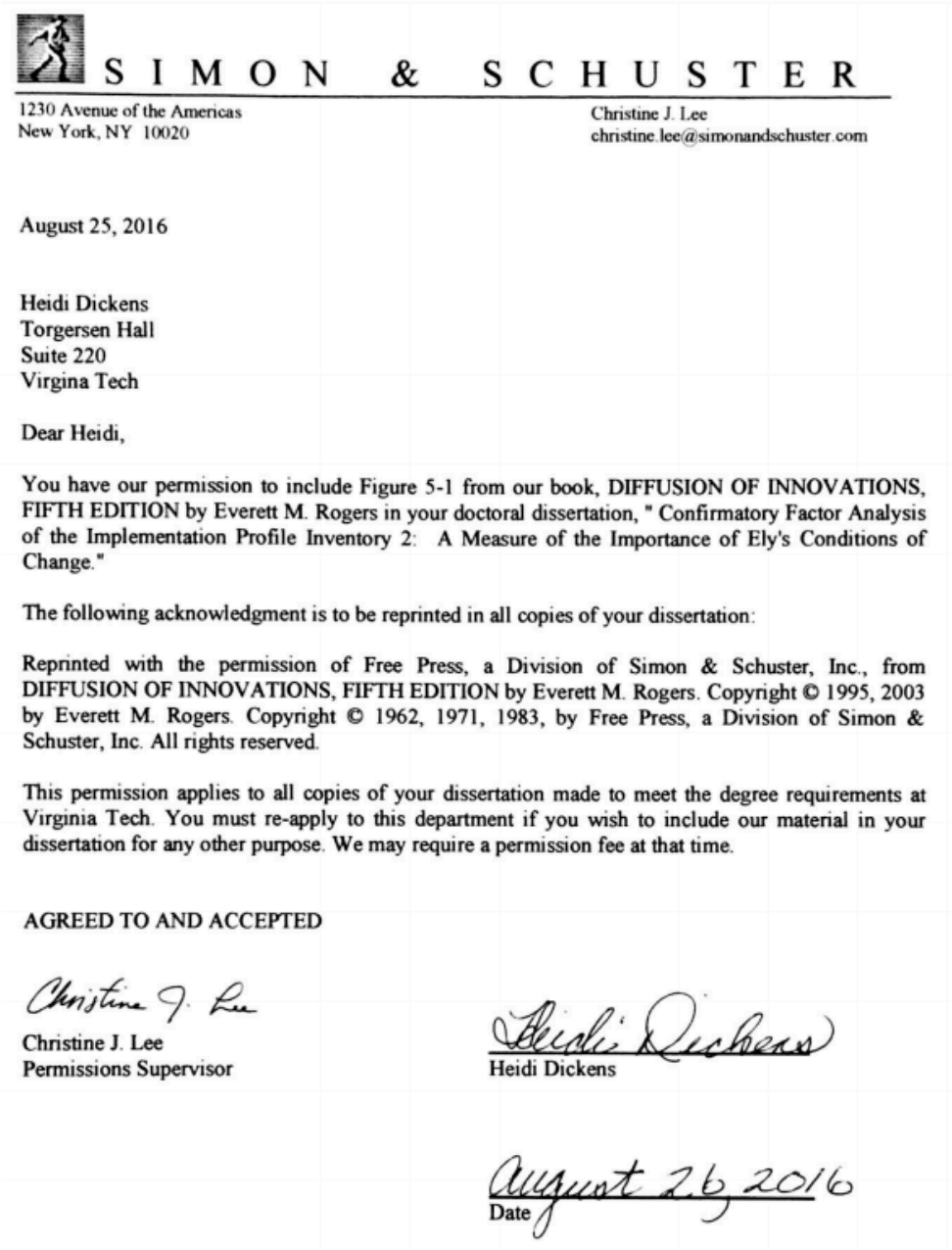
Figure 1. A Model of Five Stages in the Innovation-Decision Process (Source: Diffusion of Innovations, Fifth Edition by Everett M. Rogers. Copyright (c) 2003 by The Free Press. Reprinted with permission of the Free Press: A Division of Simon & Schuster.)



SIMON & SCHUSTER

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Christine J. Lee
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August 25, 2016

Heidi Dickens
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Dear Heidi,

You have our permission to include Figure 5-1 from our book, DIFFUSION OF INNOVATIONS, FIFTH EDITION by Everett M. Rogers in your doctoral dissertation, " Confirmatory Factor Analysis of the Implementation Profile Inventory 2: A Measure of the Importance of Ely's Conditions of Change."

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Christine J. Lee
Permissions Supervisor

Heidi Dickens

August 26, 2016
Date

Appendix C

Ely's Seven Original Conditions of Change

(Ely & Atkinson, 1976, pp. 159-161)

1. *There must be dissatisfaction with the present situation.* Another way of expressing the same condition is to say that there must be a need to change. If a librarian does not have a problem, innovation will seem irrelevant. Dissatisfaction can arise from such situations as assessment of staff productivity or perceptions of the quality of service rendered to clients.

2. *A librarian must know about possible innovations and possess the skills to implement them.* Unless a person knows about new approaches to human relations, it is unlikely that any action can take place. A librarian needs to solve his/her own problems on his/her own terms, but often has no idea how to proceed. Individuals must have the skills to develop innovative practices.

3. *A commitment must be made by all persons involved.* Psychological ownership of an innovation is important to the persons involved. If a librarian is going to spend part of his/her time in planning, preparing, and introducing an innovation, there must be a commitment to do so. Likewise, members of the staff must share the commitment if time and resources are to be made available. Related to this condition is the concept of critical mass. If only one person embarks on an innovative activity, no matter how committed, the likelihood of success is minimal; however, if one person is joined by one committed and knowledgeable colleague (preferably more), the likelihood of success is enhanced. In addition, if the library executive gives visible and tangible support, success is almost assured.

4. *Resources must be provided.* Support services vary depending upon the innovation, but there are generally two types of resources: human and material. Human resources include assistants, secretarial help and knowledgeable people—often external consultants who can help with the design, implementation and evaluation of the innovation. Material resources include such things as equipment supplies and space.

5. *Time must be made available.* Perhaps time is a resource, and it does require a commitment, but several studies have shown this condition to be so important that it qualifies for separate citation. It is not realistic to expect a librarian to sacrifice personal time to develop innovations, but it is possible to allocate professional time to implement the new activity. Usually time has to come from reallocation of existing responsibilities.

6. *There must be some reward for the effort.* Rewards vary depending upon the value system of the librarian. It is sufficient for some to gain intrinsic satisfaction from perceptions of improvement of services resulting from planned change. For

others, more tangible rewards are required. For example, the availability of time and/or resources previously unavailable might be a sufficient reward. Released time gives official recognition to the innovation and hence confers status on it. Extra help from additional staff, if necessary, might provide benefits. The resources and guidance of an empathetic consultant could help as well. The recognition, encouragement and visible acknowledgment of innovative effort by a board of trustees or administrative superiors are ego-building.

7. *There must be leadership.* Most successful innovations can be traced to a single person who has the vision, persistence, authority, and charisma to move people to action. Leadership is one of the essential conditions for change and must be exercised in an environment that possesses the other conditions. Strong leadership cannot transcend the need for resources, time and a reward system. No matter how kindly or inspired the leader may be, a staff that possesses the necessary skills and commitment is necessary to carry through the innovation.

Appendix D
Standard Factor Loadings for Alternative Factor Structure Models

Table D1

Model A (4 factors⇔49 items): Standard factor loadings showing correlations between the four factors and 49 items. This table serves to describe Figure 3, the path diagram for Model A.

Item #	Managed Change	Performance Efficacy	Resources	External Rewards
Q5	0.492			
Q6	0.411			
Q15	0.637			
Q21	0.437			
Q26	0.784			
Q36	0.781			
Q38	-0.351			
Q22	0.028			
Q29	0.065			
Q31	0.029			
Q35	0.037			
Q39	-0.061			
Q46	0.285			
Q11	0.623			
Q20	0.280			
Q23	0.553			
Q28	0.769			
Q45	0.449			
Q8		0.308		
Q2		0.486		
Q25		0.336		
Q30		0.588		
Q37		0.759		
Q47		0.479		
Q1		0.089		
Q3		0.405		
Q12		0.577		
Q14		0.423		
Q33		0.508		
Q40		0.669		
Q9		0.341		
Q13		0.647		
Q19		0.672		
Q27		0.721		
Q43		0.370		
Q48		0.640		
Q42			0.578	
Q4			0.622	
Q10			0.729	
Q18			0.796	
Q34			0.661	
Q41			0.815	
Q49			0.640	
Q44				0.605
Q7				0.335
Q16				0.297
Q17				0.784
Q24				0.351
Q32				0.830

Note: Factor loadings illustrate correlations between items and factors.
Values for factor loadings are considered weak in the 0.100 to 0.300 range, >0.300 to ≤0.500 are considered moderate and >0.500 are considered strong (Stevens, 2012).

Table D2

Model B (8 conditions⇔49 items): Standard factor loadings showing correlations between Ely's (1990) eight conditions and the 49 items. This table serves to describe Figure 4, the path diagram for Model B.

Item #	Commitment	DSS	Leadership	Knowledge	Participation	Time	Resources	RWRDSN
O5	0.515							
O6	0.429							
O15	0.662							
O21	0.433							
O26	0.797							
O36	0.773							
O38		0.441						
O22		0.795						
O29		0.626						
O31		0.292						
O35		0.890						
O39		0.365						
O46			0.304					
O11			0.635					
O20			0.281					
O23			0.541					
O28			0.796					
O45			0.475					
O8				0.340				
O2				0.506				
O25				0.365				
O30				0.624				
O37				0.783				
O47				0.526				
O1					0.129			
O3					0.514			
O12					0.695			
O14					0.555			
O33					0.618			
O40					0.747			
O9						0.435		
O13						0.692		
O19						0.685		
O27						0.807		
O43						0.437		
O48						0.685		
O42							0.582	
O4							0.618	
O10							0.728	
O18							0.797	
O34							0.661	
O41							0.817	
O49							0.636	
O44								0.596
O7								0.350
O16								0.299
O17								0.777
O24								0.382
O32								0.827

Note: Factor loadings illustrate correlations between items and factors.
Dissatisfaction with Status Quo (DSS), Skills and Knowledge (Knowledge), Incentives and Rewards (RWRDSN).
Values for factor loadings are considered weak in the 0.100 to 0.300 range, >0.300 to ≤0.500
are considered moderate and >0.500 are considered strong (Stevens, 2012).

Table D3

Model C (4 factors⇔8 conditions⇔49 items): This model consists of two tables of absolute values of correlation coefficients. Table D3 represents layer 1, which includes standard factor loadings showing the relationship between Ely's (1990) eight conditions and the 49 items (layer 1). Tables D3 and D4 serve to describe Figure 6, path diagram for Model C.

Item #	Commitment	DSS	Leadership	Knowledge	Participation	Time	Resources	RWRDSN
Q5	0.513							
Q6	0.429							
Q15	0.657							
Q21	0.430							
Q26	0.797							
Q36	0.778							
Q38		0.436						
Q22		0.783						
Q29		0.615						
Q31		0.292						
Q35		0.907						
Q39		0.369						
Q46			0.286					
Q11			0.654					
Q20			0.285					
Q23			0.575					
Q28			0.772					
Q45			0.471					
Q8				0.340				
Q2				0.521				
Q25				0.368				
Q30				0.626				
Q37				0.783				
Q47				0.508				
Q1					0.128			
Q3					0.521			
Q12					0.701			
Q14					0.541			
Q33					0.606			
Q40					0.754			
Q9						0.440		
Q13						0.698		
Q19						0.685		
Q27						0.806		
Q43						0.427		
Q48						0.682		
Q42							0.577	
Q4							0.620	
Q10							0.728	
Q18							0.796	
Q34							0.663	
Q41							0.816	
Q49							0.640	
Q44								0.604
Q7								0.337
Q16								0.298
Q17								0.782
Q24								0.353
Q32								0.832

Note: Factor loadings illustrate correlations between items and factors.
Dissatisfaction with Status Quo (DSS), Skills and Knowledge (Knowledge), Incentives and Rewards (RWRDSN).
Values for factor loadings are considered weak in the 0.100 to 0.300 range, >0.300 to ≤0.500 are considered moderate and >0.500 are considered strong (Stevens, 2012).

Table D4

Model C (4 factors⇔8 conditions ⇔49 items)*: This model consists of two tables of absolute values of correlation coefficients. Table D4 represents layer 2, which includes standard factor loadings representing the relationship between the hypothesized four-factor structure (Ensminger et al., 2004) and Ely's (1990a) eight conditions. Tables D3 and D4 serve to describe Figure 6, path diagram for Model C.*

	Managed Change	Performance Efficacy	Resources	External Rewards
Commitment	0.954			
DSS	0.045			
Leadership	0.975			
Knowledge		0.968		
Participation		0.778		
Time		0.839		
Resources			1.0	
RWRDSN				1.0

Note: Factor loadings illustrate correlations between items and factors.
Values for factor loadings are considered weak in the 0.100 to 0.300 range, >0.300 to ≤0.500 are considered moderate and >0.500 are considered strong (Stevens, 2012).

Appendix E

IPI-II Questionnaire

Part I
Investigating Conditions that Facilitate Implementation of a New Technology

Thank you for helping with my dissertation research into some of the conditions that facilitate the implementation of new technologies. Specifically, I am interested in how groups (role, college, department, years in education, years at university, etc.) view the importance of these conditions. This study focuses on Donald Ely's Eight Conditions that support the implementation of a new technology (also known as Ely's Conditions for Change:

Dissatisfaction with the Status Quo:	There is a need for the new innovation;
Sufficient Knowledge and Skills:	Intended users have the knowledge and skills to implement the new innovation;
Availability of Resources:	Resources necessary to implement change are available;
Availability of Time:	Intended users of the new innovation have time to learn, adapt, integrate and reflect;
Reward or Incentives:	Users need motivation, intrinsic or extrinsic, depending on the individual;
Participation:	Key players must have a voice in the process of adopting and implementing the new innovation;
Commitment:	Leaders at all levels buy into the process and express continuing support;
Leadership:	Key leaders provide encouragement, support, and inspiration for users.

This survey takes 10-15 minutes to complete. You will be presented with 49 statements about Ely's Eight Conditions and asked to respond to these statements using a seven-point Likert scale anchored by 1=Strongly Disagree and 7=Strongly Agree. There will be one question asking you to rank the eight conditions in order of importance. Don't think about any one statement too long. There are no right or wrong answers. At the end of the survey, you will see a set of demographic questions. No personal identifying information is requested and these data will be used for research purposes only.
By continuing to the next page, you are giving consent to participate. Thank you!

*********End of Part I – screen 1**********

Please respond to all statements and questions in this survey as they relate to the new learning management system, Canvas, and your current use or planned use of this new innovation.

Part II

Fall 2015 marked the rollout of Canvas as the new learning management system (LMS). The university will continue to support Scholar (the old learning management system) through the end of Spring 2017.

Whether you are currently using Canvas or planning to use Canvas, please consider how you feel about the following statements. Please respond to all statements as they relate to the learning management system (LMS).

1-strongly disagree, 2-disagree, 3-not sure how I feel, 4-agree, 5-strongly agree

1. Trying to get input from those responsible for using an innovation won't have any effect on the innovation anyway.
2. In my opinion, knowing how to use an innovation makes change easier.
3. The more everyone participates in the development of an innovation the more successful the innovation will be.
4. Without proper support personnel an innovation is doomed.
5. Upper management support is not necessary for an innovation to be effective.
6. I want tangible commitment not just basic lip service from the top-level executives before I consider using an innovation.
7. I am more likely to accept a change if I know I will gain something from it.
8. Most people can simply figure out how to use an innovation, no special training is required.
9. Workers should be willing to develop their skills with an innovation on their own personal time not work time.
10. In my opinion access to support personnel and materials makes change easier.
11. Having direct supervisors who actively support, provide encouragement and use the innovation is critical to the successful implementation of an innovation.
12. Most front line users are more likely to accept a innovation if they have had some say in the process.
13. In my opinion providing people the time to become familiar with an innovation makes change easier.
14. In my opinion involving everyone in the decision-making makes change much easier.
15. Having top-level executives provide reasons, explain plans, and communicate detailed strategies is critical to the successful implementation of an innovation.
16. Achieving a sense of personal satisfaction will make me more likely to use an innovation.
17. Providing rewards and incentives is critical to the successful implementation of an innovation.
18. Having access to qualified support personnel is critical to the successful implementation of an innovation.
19. Giving everyone enough time to become familiar with and comfortable is critical to the successful implementation of the innovation.

20. Low and mid level mangers who are opposed to an innovation can kill the innovation easily, even if upper level mangers support it.
21. Upper level managers can sabotage the success of an innovation even if everyone else in the organization supports it.
22. Before accepting an innovation I like to be sure the old methods are not working well.
23. For an innovation to succeed direct supervisors must also use the innovation and serve as role models to others.
24. I want to know that the innovation will help me in some way before I consider using it.
25. Innovations typically fail because people do not know how to use the innovation correctly.
26. Innovations typically fail because people do not know how to use the innovation correctly.
27. You cannot expect an innovation to work unless you give time on the job for people to become familiar and comfortable with it.
28. In my opinion managers and direct supervisors who actively support an innovation make change easier.
29. I am more willing to accept innovations if I feel the old ways are not working very well.
30. I am comfortable using innovations as long as I know training will be provided.
31. In my opinion changes occur when people are unhappy with the current way things are done.
32. In my opinion incentives or rewards makes change much easier.
33. It is important that my ideas and thoughts are listened when the organization is considering implementing an innovation.
34. Change requires not only having enough resources for everyone but also everyone having access to the resources.
35. It is important for me to feel that the current way we do things is not working before I consider a change.
36. In my opinion top-level managers who visibly support an innovation make change easier.
37. Ensuring that everyone has the required skills and knowledge is critical to the successful implementation of an innovation.
38. We should always be open to new methods even if the current methods are working well.
39. Creating a sense of dissatisfaction with the status quo is critical to the successful implementation of an innovation.
40. Creating an atmosphere of genuine participation is critical to the successful implementation of an innovation.
41. Having access to the necessary support materials and tools is critical to the successful implementation of an innovation.
42. Resources have little impact on the success of an innovation.
43. It is important to me that I do not have to spend my free time becoming familiar with an innovation.
44. Rewards or incentive rarely influence my decision to use an innovation.
45. Personal encouragement from my direct supervisor would make me more willing to use an innovation.
46. Once the innovation has been adopted by the organization, supervisors have little impact on its use.

47. I am more likely to use an innovation if I already have the skills and knowledge related to the innovation.
48. I am more likely to use an innovation if I already have the skills and knowledge related to the innovation.
49. Without enough support materials and tools an innovation will fail.

1. Please rank the order of importance for the following eight conditions. 1 being the most important and 8 being the least important

    - Dissatisfaction with the Status Quo
    - Sufficient Knowledge and Skills
    - Availability of Resources
    - Availability of Time
    - Reward or Incentives
    - Participation
    - Commitment
    - Leadership

*********End of Part II – screen 2**********

Part III

Demographics - This section consists of a short set of demographic questions. All responses are anonymous and will be used for research purposes only.

Q6. **Age:** under 18, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 or older

Q7. **Gender**: woman, man, Trans, Prefer not to say, Other (please specify)

Q8. **Organizational role with regard to the use of learning management systems (Scholar or Canvas):** teaching and research faculty, AP faculty, staff, teaching assistant, Other (please specify

Q9. **total years of teaching experience:** [text box] whole numbers only - round please

Q10. **years at Virginia Tech** [text box] whole numbers only - round please

Q11. **College Affiliation:** College of Agriculture and Life Sciences, College of Architecture and Urban Studies, College of Engineering, College of Liberal Arts and Human Science, College of Natural Resources and Environment, Pamplin College of Business, College of Science, Virginia-Maryland College of Veterinary Medicine, Virginia Tech Carilion School of Medicine, University Libraries, other (please specify)

Q12. **Department**

Q13. **Please rate your level of proficiency with educational innovation in general**:

1 - Novice (you need help when using innovation)
2 - Intermediate (you are able to independently complete tasks using innovation, but require help or training from time to time)
3 - Advanced (you have attained a level of self-efficacy with the innovation and are recognized as "a person to ask" when difficult questions arise)
4 - Expert (you are recognized as an authority and can provide guidance, troubleshoot, and answer questions regarding many technologies)

Q14. Are you currently using Canvas? Yes or No

Thank you for participating in this research!

Appendix F

Relationship of Item by Questionnaire Number to Ely's Conditions and the Hypothesized Four Factors

#	Item	Ely's (1990) Condition	Ensminger et al. (2004) Factor Structure
38 R	We should always be open to new methods even if the current methods are working well.	Dissatisfaction with Status Quo	Managed Change
35	It is important for me to feel that the current way we do things is not working before I consider a change.	Dissatisfaction with Status Quo	Managed Change
22	Before accepting an innovation I like to be sure the old methods are not working well.	Dissatisfaction with Status Quo	Managed Change
29	I am more willing to accept innovations if I feel the old ways are not working very well.	Dissatisfaction with Status Quo	Managed Change
31	In my opinion changes occur when people are unhappy with the current way things are done.	Dissatisfaction with Status Quo	Managed Change
39 V	Creating a sense of dissatisfaction with the status quo is critical to the successful implementation of an innovation.	Dissatisfaction with Status Quo	Managed Change
47	I am more likely to use an innovation if I already have the skills and knowledge related to the innovation.	Knowledge and Skills Exist	Performance Efficacy
25	Innovations typically fail because people do not know how to use the innovation correctly.	Knowledge and Skills Exist	Performance Efficacy
30	I am comfortable using innovations as long as I know training will be provided.	Knowledge and Skills Exist	Performance Efficacy
8 R	Most people can simply figure out how to use an innovation, no special training is required.	Knowledge and Skills Exist	Performance Efficacy
2	In my opinion, knowing how to use an innovation makes change easier.	Knowledge and Skills Exist	Performance Efficacy
37 V	Ensuring that everyone has the required skills and knowledge is critical to the successful implementation of an innovation.	Knowledge and Skills Exist	Performance Efficacy
34	Change requires not only having enough resources for everyone but also everyone having access to the resources.	Resources are Available	Resources
49	Without enough support materials and tools an innovation will fail.	Resources are Available	Resources
4	Without proper support personnel an innovation is doomed.	Resources are Available	Resources
42 R	Resources have little impact on the success of an innovation.	Resources are Available	Resources
10	In my opinion access to support personnel and materials makes change easier.	Resources are Available	Resources

41 V	Having access to the necessary support materials and tools is critical to the successful implementation of an innovation.	Resources are Available	Resources
18 V	Having access to qualified support personnel is critical to the successful implementation of an innovation.	Resources are Available	Resources
43	It is important to me that I do not have to spend my free time becoming familiar with an innovation.	Time is Available	Performance Efficacy
9 R	Workers should be willing to develop their skills with an innovation on their own personal time not work time.	Time is Available	Performance Efficacy
48	Organizations must schedule time for employees to become familiar and comfortable with an innovation.	Time is Available	Performance Efficacy
27	You cannot expect an innovation to work unless you give time on the job for people to become familiar and comfortable with it.	Time is Available	Performance Efficacy
13	In my opinion providing people the time to become familiar with an innovation makes change easier.	Time is Available	Performance Efficacy
19 V	Giving everyone enough time to become familiar with and comfortable is critical to the successful implementation of the innovation.	Time is Available	Performance Efficacy
7	I am more likely to accept a change if I know I will gain something from it.	Rewards or Incentives Exist for Participants	Ext. Rewards
24	I want to know that the innovation will help me in some way before I consider using it.	Rewards or Incentives Exist for Participants	Ext. Rewards
16	Achieving a sense of personal satisfaction will make me more likely to use an innovation.	Rewards or Incentives Exist for Participants	Ext. Rewards
44 R	Rewards or incentive rarely influence my decision to use an innovation.	Rewards or Incentives Exist for Participants	Ext. Rewards
32	In my opinion incentives or rewards makes change much easier.	Rewards or Incentives Exist for Participants	Ext. Rewards
17 V	Providing rewards and incentives is critical to the successful implementation of an innovation.	Rewards or Incentives Exist for Participants	Ext. Rewards
12	Most front line users are more likely to accept a innovation if they have had some say in the process.	Participation is Expected and Encouraged	Performance Efficacy
33	It is important that my ideas and thoughts are listened when the organization is considering implementing an innovation.	Participation is Expected and Encouraged	Performance Efficacy
3	The more everyone participates in the development of an innovation the more successful the innovation will be.	Participation is Expected and Encouraged	Performance Efficacy
1 R	Trying to get input from those responsible for using an innovation won't have any effect on the innovation anyway.	Participation is Expected and Encouraged	Performance Efficacy

14	In my opinion involving everyone in the decision-making makes change much easier.	Participation is Expected and Encouraged	Performance Efficacy
40 V	Creating an atmosphere of genuine participation is critical to the successful implementation of an innovation.	Participation is Expected and Encouraged	Performance Efficacy
5 R	Upper management support is not necessary for an innovation to be effective.	Commitment by Those Who are Involved	Managed Change
26	Senior management's actions are pivotal in fostering the implementation of an innovation.	Commitment by Those Who are Involved	Managed Change
21	Upper level managers can sabotage the success of an innovation even if everyone else in the organization supports it.	Commitment by Those Who are Involved	Managed Change
6	I want tangible commitment not just basic lip service from the top-level executives before I consider using an innovation.	Commitment by Those Who are Involved	Managed Change
36	In my opinion top-level managers who visibly support an innovation make change easier.	Commitment by Those Who are Involved	Managed Change
15 V	Having top-level executives provide reasons, explain plans, and communicate detailed strategies is critical to the successful implementation of an innovation.	Commitment by Those Who are Involved	Managed Change
45	Personal encouragement from my direct supervisor would make me more willing to use an innovation.	Leadership is Evident	Managed Change
23	For an innovation to succeed direct supervisors must also use the innovation and serve as role models to others.	Leadership is Evident	Managed Change
20	Low and mid level managers who are opposed to an innovation can kill the innovation easily, even if upper level managers support it.	Leadership is Evident	Managed Change
46 R	Once the innovation has been adopted by the organization supervisors have little impact on its use.	Leadership is Evident	Managed Change
28	In my opinion managers and direct supervisors who actively support an innovation make change easier.	Leadership is Evident	Managed Change
11 V	Having direct supervisors who actively support, provide encouragement and use the innovation is critical to the successful implementation of an innovation.	Leadership is Evident	Managed Change

Note: **R** designates a question that was reverse coded in data preparation process. **V** designates a question identified as a validation question by the developers. Ensminger and Surry (D. Ensminger, personal communication May, 14, 2015) planned to use these questions to correlate with individual scores and/or serve as a member check for additional construct validity gathered via a separate qualitative part of the online questionnaire. The collection and analysis of qualitative data was beyond the scope of the current study.

Appendix G

IRB Protocol Approval #16-004

VirginiaTech

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
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website http://www.irb.vt.edu

MEMORANDUM

DATE: June 1, 2016

TO: Ken Potter, Heidi Dickens

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)

PROTOCOL TITLE: Confirmatory Factor Analysis on the Implementation Profile Inventory 2: A Measure of the Importance of Ely's Conditions of Change

IRB NUMBER: **16-004**

Effective May 31, 2016, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Amendment request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Exempt, under 45 CFR 46.110 category(ies) 2,4**
Protocol Approval Date:	**May 2, 2016**
Protocol Expiration Date:	**N/A**
Continuing Review Due Date*:	**N/A**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Appendix H
Frequencies and Percentages Demographic Variables

Table H1
Frequencies and Percentages for Categorical Demographic Variables

	N	%
Age Range		
Under 18	**0**	
18-24	**4**	**1.6**
25-34	**29**	**11.5**
35-44	**58**	**23.0**
45-54	**56**	**22.2**
55-64	**77**	**30.6**
65-74	**17**	**6.7**
75 or older	**8**	**3.2**
Missing	**3**	**1.2**
Gender		
Woman	**110**	**43.7**
Man	**132**	**52.4**
Trans	**2**	**.8**
Prefer not to say	**1**	**.4**
Other	**2**	**.8**
Missing	**5**	**2.0**
Organizational Role		
Teaching and Research Faculty	**163**	**64.7**
AP Faculty	**50**	**19.8**
Staff	**9**	**3.6**
Teaching Assistant	**23**	**9.1**
Other, please specify	**4**	**1.6**
Missing	**3**	**1.2**

College Affiliation		
Agriculture and Life Sciences	**37**	**14.68**
Architecture and Urban Studies	**13**	**5.16**
Engineering	**40**	**15.87**
Liberal Arts and Human Sciences	**56**	**22.22**
Natural Resources and Environment	**11**	**4.36**
Business	**24**	**9.52**
Science	**30**	**11.90**
Veterinary Medicine	**5**	**2.00**
Medicine	**0**	
University Libraries	**4**	**1.59**
Other, please specify	**26**	**10.31**
Missing	**6**	**2.39**
Level of Proficiency with Technology		
Novice	**12**	**4.80**
Intermediate	**131**	**52.0**
Advanced	**87**	**34.50**
Expert	**19**	**7.50**
Missing	**3**	**1.20**
Using New LMS		
Yes	**117**	**46.40**
No	**130**	**51.60**
Missing	**5**	**2.00**

Table H2

Frequencies and Percentages for Continuous Demographic Variables

	N	**Mean**	**Mode**	**Min**	**Max**
Years teaching	242	17.2	2	0	55
Years at university	239	12.6	2	0	45

Appendix I
Item Response Data

Table I1

Item Analysis

Item*	Response Frequency							Range		Diff.	SD	Disc.
	1	2	3	4	5	6	7	Min.	Max.	Mean		
1	7	15	29	43	36	72	50	1	7	4.992	1.644	0.108
2	0	1	2	5	26	123	97	2	7	6.202	0.815	0.449
3	2	8	24	32	64	76	46	1	7	5.222	1.382	0.352
4	1	2	14	13	59	96	67	1	7	5.710	1.163	0.519
5	7	15	36	13	50	86	45	1	7	5.071	1.632	0.321
6	5	17	25	55	50	61	39	1	7	4.853	1.545	0.441
7	0	4	7	12	49	98	82	2	7	5.889	1.098	0.398
8	0	9	39	31	65	74	34	2	7	5.023	1.385	0.331
9	2	3	10	16	38	82	101	1	7	5.916	1.245	0.284
10	0	2	6	6	39	110	89	2	7	6.047	0.973	0.538
11	1	5	8	24	86	79	49	1	7	5.468	1.158	0.519
12	0	2	11	29	69	106	35	2	7	5.472	1.057	0.536
13	0	0	8	8	55	105	76	3	7	5.924	0.964	0.523
14	6	21	47	35	70	44	29	1	7	4.547	1.567	0.393
15	1	11	20	32	73	79	36	1	7	5.166	1.328	0.572
16	0	1	3	36	68	90	54	2	7	5.607	1.037	0.381
17	3	9	34	74	75	38	57	1	7	4.583	1.276	0.399
18	0	0	6	9	52	99	86	3	7	5.992	0.953	0.620
19	0	3	12	11	60	103	63	2	7	5.734	1.102	0.576
20	0	11	13	31	86	65	46	2	7	5.265	1.283	0.245
21	0	3	12	21	61	100	155	2	7	5.619	1.128	0.373
22	13	34	50	55	48	28	24	1	7	4.075	1.643	0.322
23	5	18	31	41	80	51	26	1	7	4.706	1.467	0.493
24	1	7	16	27	82	70	49	1	7	5.333	1.275	0.459
25	1	19	39	64	71	41	17	1	7	4.492	1.340	0.346
26	0	9	16	42	86	78	21	2	7	5.075	1.176	0.554
27	0	2	2	13	54	109	72	2	7	5.912	0.949	0.640
28	0	2	1	17	74	117	41	2	7	5.690	0.893	0.556
29	0	8	14	19	52	97	62	2	7	5.595	1.266	0.323
30	1	5	15	43	69	90	29	1	7	5.222	1.193	0.529
31	4	14	43	53	7	52	12	1	7	4.519	1.349	0.138
32	1	7	15	63	89	60	17	1	7	4.904	1.142	0.383
33	1	4	19	40	83	69	36	1	7	5.186	1.217	0.499
34	1	1	1	18	49	107	75	1	7	5.912	0.986	0.589
35	5	29	56	43	54	41	24	1	7	4.313	1.579	0.344
36	1	0	12	35	82	89	33	1	7	5.365	1.068	0.552
37	1	2	9	24	67	94	55	1	7	5.603	1.122	0.667
38	38	72	79	30	17	12	4	1	7	2.873	1.397	-0.125
39	21	49	73	58	41	8	2	1	7	3.321	1.313	0.057
40	2	2	17	30	84	86	31	1	7	5.277	1.161	0.601
41	0	0	5	12	49	107	79	3	7	5.964	0.937	0.600
42	2	2	8	15	47	97	81	1	7	5.849	1.157	0.422
43	2	12	21	35	50	69	63	1	7	5.293	1.491	0.357
44	12	37	53	45	68	29	8	1	7	3.949	1.499	0.193
45	4	10	12	56	87	64	19	1	7	4.904	1.255	0.301
46	9	26	41	42	66	52	16	1	7	4.388	1.553	0.097
47	0	7	13	17	59	105	51	2	7	5.567	1.197	0.474
48	0	1	9	12	46	101	83	2	7	5.928	1.042	0.558
49	1	7	14	23	79	69	59	1	7	5.440	1.284	0.574

Note for Table I1: Values are presented as number of respondents selecting each response (see Figure 6). Response choices were 1=Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree or disagree, 5=Somewhat agree, 6=Agree, 7=Strongly agree.

***The survey questions to accompany Table I1 on previous page.**

1. Trying to get input from those responsible for using an innovation won't have any effect on the innovation anyway.
2. In my opinion, knowing how to use an innovation makes change easier.
3. The more everyone participates in the development of an innovation the more successful the innovation will be.
4. Without proper support personnel an innovation is doomed.
5. Upper management support is not necessary for an innovation to be effective.
6. I want tangible commitment not just basic lip service from the top-level executives before I consider using an innovation.
7. I am more likely to accept a change if I know I will gain something from it.
8. Most people can simply figure out how to use an innovation, no special training is required.
9. Workers should be willing to develop their skills with an innovation on their own personal time not work time.
10. In my opinion access to support personnel and materials makes change easier.
11. Having direct supervisors who actively support, provide encouragement and use the innovation is critical to the successful implementation of an innovation.
12. Most front line users are more likely to accept an innovation if they have had some say in the process.
13. In my opinion providing people the time to become familiar with an innovation makes change easier.
14. In my opinion involving everyone in the decision-making makes change much easier.
15. Having top-level executives provide reasons, explain plans, and communicate detailed strategies is critical to the successful implementation of an innovation.
16. Achieving a sense of personal satisfaction will make me more likely to use an innovation.
17. Providing rewards and incentives is critical to the successful implementation of an innovation.
18. Having access to qualified support personnel is critical to the successful implementation of an innovation.
19. Giving everyone enough time to become familiar with and comfortable is critical to the successful implementation of the innovation.
20. Low and mid level managers who are opposed to an innovation can kill the innovation easily, even if upper level mangers support it.
21. Upper level managers can sabotage the success of an innovation even if everyone else in the organization supports it.
22. Before accepting an innovation, I like to be sure the old methods are not working well.
23. For an innovation to succeed, direct supervisors must also use the innovation and serve as role models to others.
24. I want to know that the innovation will help me in some way before I consider using it.
25. Innovations typically fail because people do not know how to use the innovation correctly.
26. Innovations typically fail because people do not know how to use the innovation correctly.

27. You cannot expect an innovation to work unless you give time on the job for people to become familiar and comfortable with it.
28. In my opinion managers and direct supervisors who actively support an innovation make change easier.
29. I am more willing to accept innovations if I feel the old ways are not working very well.
30. I am comfortable using innovations as long as I know training will be provided.
31. In my opinion changes occur when people are unhappy with the current way things are done.
32. In my opinion incentives or rewards makes change much easier.
33. It is important that my ideas and thoughts are listened when the organization is considering implementing an innovation.
34. Change requires not only having enough resources for everyone but also everyone having access to the resources.
35. It is important for me to feel that the current way we do things is not working before I consider a change.
36. In my opinion, top-level managers who visibly support an innovation make change easier.
37. Ensuring that everyone has the required skills and knowledge is critical to the successful implementation of an innovation.
38. We should always be open to new methods even if the current methods are working well.
39. Creating a sense of dissatisfaction with the status quo is critical to the successful implementation of an innovation.
40. Creating an atmosphere of genuine participation is critical to the successful implementation of an innovation.
41. Having access to the necessary support materials and tools is critical to the successful implementation of an innovation.
42. Resources have little impact on the success of an innovation.
43. It is important to me that I do not have to spend my free time becoming familiar with an innovation.
44. Rewards or incentive rarely influence my decision to use an innovation.
45. Personal encouragement from my direct supervisor would make me more willing to use an innovation.
46. Once the innovation has been adopted by the organization, supervisors have little impact on its use.
47. I am more likely to use an innovation if I already have the skills and knowledge related to the innovation.
48. I am more likely to use an innovation if I already have the skills and knowledge related to the innovation.
49. Without enough support, materials, and tools an innovation will fail.

Appendix J

Email to Potential Participants

Thank you for helping with my dissertation research. I am studying conditions that facilitate the implementation of new technologies. Specifically, I am looking at how different groups (role, college, department, years in education, years at university, etc.) view the importance of these conditions.

Your participation in this study will require you to complete one brief questionnaire. This questionnaire contains 49 short statements, and a short set of demographic questions at the end. The entire questionnaire should take about 5-7 minutes to complete.

My research and this questionnaire have been approved by the Institutional Review Board of Virginia Tech to ensure compliance with proper research standards. Your responses to the questionnaire will be confidential and no information that can be used to identify you will be reported. The ONLY thing I would like you to do is complete this one questionnaire—you will not be asked to perform any follow up activities and you will not be contacted by anyone afterwards. No information about you individually or your responses will be made available to anyone else. Your participation in this study is voluntary.

I would appreciate your completing the questionnaire prior to [date]. If you have questions or comments about my research or the questionnaire, please contact Heidi Dickens heidi1@vt.edu or Dr. Ken Potter kpotter@vt.edu.

If you consent to participate in this research, please click on the link below to begin the questionnaire.

CLICK HERE TO BEGIN THE SURVEY

Thank you,
Heidi Dickens

Appendix K
Synthesis of Item Response Analysis

Table K1

Item #	Reliability	Discrimination	Model A	Model B	Model C	Condition
****Q5	0.9086	0.321	0.492	0.513	0.513	Communication
Q6	0.9069	0.441	0.411	0.429	0.429	Communication
Q15	0.9054	0.572	0.637	0.662	0.657	Communication
Q21	0.9077	0.373	0.437	0.433	0.430	Communication
Q26	0.9058	0.554	0.784	0.797	0.797	Communication
Q36	0.9060	0.552	0.781	0.773	0.778	Communication
Q22	0.9087	0.322	***0.028	0.795	0.783	DSS
Q29	0.9082	0.323	***0.065	0.626	0.615	DSS
Q31	0.9014	**0.138	***0.029	***0.292	***0.292	DSS
Q35	0.9083	0.344	***0.037	0.890	0.907	DSS
****Q38	*0.9135	**-0.125	***-0.351	0.441	0.436	DSS
Q39	*0.9112	**0.057	***-0.061	0.365	0.369	DSS
Q7	0.9074	0.398	0.335	0.335	0.337	Incentives & Rewards
Q16	0.9076	0.381	***0.297	***0.299	***0.298	Incentives & Rewards
Q17	0.9074	0.399	0.784	0.777	0.782	Incentives & Rewards
Q24	0.9067	0.459	0.351	0.382	0.353	Incentives & Rewards
Q32	0.9076	0.383	0.830	0.827	0.832	Incentives & Rewards
****Q44	*0.9101	**0.193	0.605	0.596	0.604	Incentives & Rewards
Q11	0.9062	0.519	0.623	0.304	0.654	Leadership
Q20	0.9091	**0.245	***0.280	***0.282	***0.285	Leadership
Q23	0.9063	0.493	0.553	0.541	0.575	Leadership
Q28	0.9064	0.556	0.769	0.793	0.772	Leadership
Q45	0.9084	0.301	0.449	0.475	0.471	Leadership
****Q46	*0.9115	**0.097	***0.285	0.304	***0.286	Leadership
****Q1	*0.9116	**0.108	***0.089	***0.129	***0.128	Participation
Q3	0.9080	0.352	0.405	0.514	0.521	Participation
Q12	0.9062	0.539	0.577	0.695	0.701	Participation
Q14	0.9076	0.393	0.423	0.555	0.541	Participation
Q33	0.9064	0.499	0.508	0.618	0.606	Participation
Q40	0.9054	0.601	0.669	0.747	0.754	Participation
Q4	0.9062	0.519	0.622	0.618	0.620	Resources
Q10	0.9064	0.538	0.729	0.728	0.728	Resources
Q18	0.9057	0.620	0.796	0.797	0.796	Resources
Q34	0.9059	0.589	0.661	0.661	0.663	Resources
Q41	0.9059	0.600	0.815	0.817	0.816	Resources
****Q42	0.9072	0.422	0.578	0.582	0.577	Resources
Q49	0.9055	0.574	0.640	0.636	0.64	Resources
Q2	0.9073	0.449	0.486	0.506	0.521	Skills & Knowledge
****Q8	0.9082	0.331	0.308	0.340	0.34	Skills & Knowledge
Q25	0.9080	0.346	0.336	0.365	0.368	Skills & Knowledge
Q30	0.9061	0.529	0.588	0.624	0.626	Skills & Knowledge
Q37	0.9048	0.667	0.759	0.783	0.783	Skills & Knowledge
Q47	0.9066	0.474	0.479	0.526	0.508	Skills & Knowledge
****Q9	0.9086	**0.284	0.341	0.435	0.44	Time
Q13	0.9065	0.523	0.647	0.692	0.698	Time
Q19	0.9057	0.576	0.672	0.685	0.685	Time
Q27	0.9056	0.640	0.721	0.807	0.806	Time
Q43	0.9080	0.357	0.370	0.437	0.427	Time
Q48	0.9060	0.558	0.640	0.685	0.682	Time

Note: Asterisks indicate items to consider for removal based on the current study's threshold values. *Coefficient alpha=0.9092 (used to determine removal of item based on reliability); **Discrimination ≥0.25=good; ***Factor loading 0.100—0.300=weak, >0.300—≤0.500=moderate, >0.500=strong; ****Items were reverse coded.

Appendix L
Factor Analysis Report Files (Supplemental Materials)

Collaboration with a team of statisticians led by Daniel Berry, produced a report that included a factor analysis of the three alternative factor structure models. The author provided the factor analysis report with minimal annotations and the R markdown format file as supplemental materials. The statisticians' expertise with R programing syntax allowed them to move through several latent variable analysis packages (lavaan package and semPlot). Graphics illustrating CFA solutions (path diagrams) for the alternative factor structure models were generated and are presented in Chapter Four.

Items in this Dataset:

- Dickens_HE_D_2016_analysis_original-R-markdown.Rmd
    - This dataset consists of 252 university faculty, staff, and teaching assistants responses to the 49 items in the IPI-II and the corresponding syntax for specifying Model A (4 factors⇔49 items), Model B (8 factors⇔49 items), and Model C Layer 2 (4 factors⇔8 conditions). Additionally, summary tables for the demographic questions are included. R and RMarkdown package are required to open the .rmd file**.** R is free software. https://www.r-project.org/ provides a link to download the software in addition to a link to FAQs and email contact information. Open .rmd file and press "render".
- Dickens_HE_D_2016_annotated_analysis.pdf
    - This file represents the rendered factor analysis report with visualizations of the three alternative models and minimal annotations. Adobe Acrobat Reader

will open the .pdf file. Adobe Acrobat Reader is free software. https://get.adobe.com/reader/ provides a link to the download.

Supplemental Material for "A Revised Measure of Ely's Conditions of Change: Initial Psychometric Properties of the Implementation Profile Inventory II" is presented as the author submitted it. VTechData assumes no liability for errors or omissions and makes no warranties of any kind. VTechData assumes no responsibility for any reader's use of the materials. All questions regarding the supplemental data should be directed to the author of the published dissertation. The reader is expected to respect the intellectual property of the author and the copyright of the VTechData. The content should not be reused without permission from the author and VTechData.

VTechWorks URL for dataset https://data.lib.vt.edu/collections/t435gc97w

DOI (citation) for dataset. doi:10.7294/W4PN93HG