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Epistemic Beliefs and the Innovation-Decision Process: A Mixed Methods Analysis of Faculty Classroom Assessment Practice

Sharon G. Peterson
sharphyg@cox.net

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EPISTEMIC BELIEFS AND THE INNOVATION-DECISION PROCESS: A MIXED METHODS ANALYSIS OF FACULTY CLASSROOM ASSESSMENT PRACTICE

By

Sharon G Peterson

Bachelor of Science – Dental Hygiene
Idaho State University
1988

Master of Education – Educational Leadership
University of Nevada Las Vegas
1998

A dissertation submitted in partial fulfillment of the requirements for the

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College of Education
The Graduate College

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This dissertation prepared by

Sharon G. Peterson

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Department of Educational Psychology and Higher Education

Lisa D. Bendixen, Ph.D.
Examination Committee Chair

Alice Corkill, Ph.D.
Examination Committee Member

Gwen Marchand, Ph.D.
Examination Committee Member

Kim Barchard, Ph.D.
Graduate College Faculty Representative

Kathryn Hausbeck Korgan, Ph.D.
Graduate College Interim Dean
Abstract

Epistemic Beliefs and the Innovation-Decision Process: A Mixed Methods Analysis of Faculty Classroom Assessment Practice

By
Sharon G Peterson

Dr. Lisa D. Bendixen, Examination Committee Chair
Associate Professor of Educational Psychology and Higher Education
University of Nevada, Las Vegas

This study focuses on epistemic belief change and the innovation-decision processes of 193 faculty who participated in a professional development workshop series on classroom assessment. From this study population, focus groups were conducted with a criterion-based research sample of 30 workshop participants (i.e., spring workshop completers n = eight, spring workshop non-completers n = eight, fall workshop completers n = seven, and fall workshop non-completers n = seven). Very little attention in higher education research is devoted to how faculty conceptualize new knowledge during professional development, and how decisions about new knowledge affect existing knowledge. This study addresses this gap by examining the mechanisms of epistemic belief change as it pertains to faculty epistemic beliefs about assessment of learning. Components from Diffusion of Innovations (Rogers, 2003) were embedded into the Integrated Model of personal epistemology development (Bendixen & Rule, 2004) and examined in a new conceptual model, the Integrated Model of Innovation Decision-Making (IM-IDM), to explore mechanisms of epistemic belief change. The purpose of this convergent parallel mixed methods study was to examine the cognitive processes of epistemic change (i.e., epistemic doubt, epistemic volition, resolution strategies, affect, reciprocal causation, and metacognition) and determine the influence of two professional development teaching strategies (i.e., innovativeness and collaborative learning) on faculty epistemic beliefs, as well as how epistemic change is associated with the innovation-decision process when faculty consider adopting innovative classroom assessment strategies. Findings indicate statistically significant increases in sophistication of faculty beliefs for all four epistemic domains after completing a professional development series. Additionally, an examination of cognitive processes
used in innovation decision-making suggest that attributes of innovativeness have a role in pre-decisions and epistemic beliefs have a role in both pre-decisions and decisions. However, the role of collaborative learning was not evident within in this study. The findings of this study may have pragmatic value to higher education institutions interested in social and personal change strategies. It is recommended that future research of the IM-IDM be conducted with a larger sample size and determine direct, indirect, and mediation effects of innovativeness and collaborative learning on faculty epistemic beliefs.

*Keywords:* epistemic belief change, innovativeness, collaborative learning, professional development
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DEDICATION

This work is dedicated to my father, the late Alfred George Gillingwater Jr., who taught me effort and dedication builds character. As well, to the stalwart and visionary explorer James Arthur Lovell Jr., failure was not an option!
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CHAPTER 1: INTRODUCTION

Assessment of learning (assessment) serves an important function by providing evidence of teaching, learning, and achievement processes. Assessment is also a key component of institutional improvement. A significant number of faculty consistently express resistance to college protocols of documenting and reporting their course assessment practices (Buhrman, 2015; Grunwald & Peterson, 2003; Haviland 2009a) and assessment of programs across the broader campus community (Emil & Cress, 2014; Haviland 2009b; Marrs, 2009; Trullen & Rodriguez, 2013; Wang & Hurley, 2011). Faculty reasons for resistance to assessment of student learning include unwillingness to engage in assessment activities outside of dedicated classroom time (Haviland 2009b; Marrs, 2009), perception of assessment of learning as burdensome (Trullen & Rodriguez, 2013), or perception of assessment of learning as an infringement on their academic freedom (Buhrman, 2015). Faculty with a teacher-centered rather than learner-centered approach to instruction have a tendency to believe that assessment of learning is solely a function of institutional accountability (Ewell, 2002; Sujitparapitaya, 2014). This belief impedes institutional initiatives to establish a positive culture of assessment on campuses and ultimately negatively affect teaching and learning in the classroom (Palomba & Banta, 2014).

Many faculty are unaware of innovative learner-centered approaches to classroom assessment (Huba & Freed, 2000) or that the use of specific validated classroom assessment techniques (CATs: Angelo & Cross, 1993) can address their concerns about the amount of time needed to plan and assess learning in the classroom. Faculty who come from industry into academia without any formal instruction in teaching and assessment methodology have expressed concern about not having adequate knowledge and training in classroom assessment.
(Mundy, Kupczynski, Ellis, & Salgado, 2012). However, many colleges and universities offer professional development courses, yet faculty generally do not take advantage of professional development opportunities (Mundy, Kupczynski, Ellis, & Salgado, 2012; Shagrir, 2013).

The epistemic beliefs of teachers (i.e., beliefs about knowledge and knowing) can affect classroom-teaching strategies and the content taught (Olafson, Schraw, & Vander Veldt, 2010; Roth & Weinstock, 2013) as well as influence measures used for assessment of student learning (Chai, Teo, & Lea, 2010). It is clear in the literature there is a need for faculty to adopt learner-centered beliefs and behaviors related to assessment in order to assure authentic reporting of student learning outcome achievement (Haviland, 2009; Huba & Freed, 2000; Marrs, 2009; Palomba & Banta, 2014).

Chapter 1 includes a brief review of relevant literature and provides a description of the significance and purpose of the study. The literature reviewed to support this study includes a brief historical account of the assessment movement in higher education; the influence of social change strategies in higher education; and relevant research and theory on epistemology and epistemic beliefs to support the theoretical framework for this study. After the overview of the literature, the research questions and expectations are presented along with a description of the research design, variables, and definitions of terms, limitations, and significance of the study.

**Overview of Literature**

A review of relevant literature focuses on key issues surrounding assessment in higher education. First, I provide a historical overview of assessment in higher education. This review addresses faculty concerns and resistance to assessment, strategies to create a culture of assessment on campus, and professional development methods. Second, research and theory supporting social change strategies reveal gaps and future research needs. Finally, I consider
extant research related to faculty epistemic beliefs to determine a theoretical model for studying decision-making that supports the purpose, research questions, and expectations described in the current study.

Assessment in Higher Education

Assessment methodology has varied extensively in higher education over the past 40 years (Kuh et al., 2015). In that timeframe, two core philosophical paradigms have shifted that directly influence faculty and their teaching responsibilities: an accountability versus improvement perception of assessment and a teacher-centered versus learner-centered perception of assessment (Ewell, 2011; Huba & Freed, 2000). A brief explanation of these perspectives will frame the literature reviewed on faculty resistance to assessment and methods of engaging faculty in assessment, two residual issues that have not been fully resolved within the assessment movement in higher education.

Accountability versus improvement perspective. An increased demand for assessment activity from higher education institutions in the early 1980s resulted from federal and state entities requiring evidence of institutional effectiveness (Ewell, 2002; 2011; Huba & Freed, 2000). As a result, many faculty perceived the purpose of assessment as an institutional accountability activity (Banta, 2002). By the late 1990s, accreditation agencies, as peer evaluators, attempted to shift the perception of collecting assessment data for accountability to documenting assessment findings for institutional improvement (Ewell, 2011). Faculty, however, still perceived accreditation agencies as stakeholders of accountability and the wrong social network to lead transformative change (Haviland, 2009; Marrs, 2009). In addition to shifting perceptions of assessment, shifts occurred in the perceived value and use of technology in education. Technology integration in higher education increased and, as a result, led to greater
 possibilities for measuring student performance and capability of reporting student ability (Kuh et al., 2015).

**Teacher-centered versus learner-centered perspective.** Historically, teaching has reflected passive learning with the teacher lecturing to impart their wisdom and the student receiving the information with minimal discussion to demonstrate comprehension. Huba and Freed (2000) describe this paradigm as teaching disassociated from learning where each entity (i.e., student and teacher) perceives their role as independent. Similarly, faculty view teaching and assessment as separate functions carried out in the classroom with determined timeframes of implementation. The literature has shown links between teaching-centered instruction and traditional views and practice of assessment. As well, assessment experts have drawn associations between learner-centered instruction and innovative practice of assessment (Angelo & Cross, 1993; Huba & Freed, 2000; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009) but this needs more research. Shifting paradigms about the purpose of assessment requires a large-scale approach first to create a culture of assessment among a diverse social structure of faculty.

**Establishing a culture of assessment.** Research has shown that faculty often resist institutional assessment initiatives or procedures that are top-down rather than faculty-driven (Lane, Lane, Rich, & Wheeling, 2014) contributing to a negative culture of assessment on campus. Specifically, an absence of clarity in the purpose of assessment, concerns about the effect of assessment, unpreparedness to conduct assessment, and an absence of a unified institutional effort to pursue assessment are key concerns for both faculty and institutional leaders across the United States (Palomba & Banta, 2014). Institutions must establish a positive culture of assessment by providing clarity in the purpose and expectations of assessment activities within the institution along with support and resources to foster faculty, administrator,
and staff buy-in (Beckwith, Silverstone, & Bean, 2010). The literature suggests that professional development can increase and change faculty beliefs and concerns about assessment, and motivate faculty to engage in assessment activities (Haviland, 2009; Piascik & Bird, 2008; Sujitparapitaya, 2014).

Many institutions of higher education establish professional development centers to support educators in their teaching responsibilities and offer courses in teaching and assessment methodology, learning technology, course management, and curriculum design (Mundy, Kupczynski, Ellis, & Salgado, 2012; Shagrir, 2011; Stes, Coertjens, & Van Petegem, 2010). Faculty have expressed misconceptions related to assessment (Haviland, 2009; Marrs, 2009). For example, many faculty do not recognize that their concerns about assessment requiring extra time outside of the classroom can be alleviated by using embedded or in-class assessment assignments (Suskie, 2009) such as Classroom Assessment Techniques (CATS; Angelo & Cross, 1993). CATs are innovative pre-designed assessment activities and measures embedded in class activities to measure authentic student ability (Angelo & Cross, 1993). The inclusion of CATs in faculty professional development could address faculty concerns about assessment and could change faculty epistemic beliefs about the purpose and use of assessment (Angelo & Cross, 199; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009).

Social Change Strategies

Higher education leaders use various strategies to achieve social change across institutions (Kezar, 2014). However, diffusion of innovations (DI) posed by Rogers (2003) is the most commonly used theoretical model for framing higher education strategies to change faculty perspectives of assessment (Blumberg, 2016; Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011). DI theory (Rogers, 2003) outlines a process of change whereby a broadly used
communication medium allows individuals within a social group to weigh the innovativeness of an intervention’s attributes, thus, significantly influencing the decision-making of the social structure to adopt the intervention (innovation). Rogers (2003) defines an innovation as an “idea, practice, or object that is perceived as new by an individual or other unit of adoption” (p. 12) and further clarifies that the idea itself can be an existing item presented in a new way. Innovations have personal relevance or value to individuals and groups according to five attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). The longer an individual is exposed to the attributes of the innovation (i.e., practice and experience), the greater the effect on an individual’s decision to adopt the concept as useful.

Social influences affect the specific process of judging an individual uses to determine adoption of an innovation (Rogers, 2003). However, little research has been conducted on the social influences and change that occur when faculty consider new knowledge about assessment or consider assessment in innovative ways. How the innovation-decision process relates to faculty epistemic beliefs about assessment of learning and the epistemic change that occurs, has yet to be discovered, and is the focus of the current study. In addition, DI theory has experienced very little change since its inception when technology was just starting to emerge in higher education. The concept of innovation may or may not have the same meaning or value now as it once did. Therefore, an examination of epistemic belief and innovation constructs within change theories could prove insightful. Next, is a summary of research and literature on processes related to epistemic belief formation and change.

Belief Constructs Foundational to Teaching, Learning, and Assessment

Individual’s beliefs about knowledge and how we interpret, evaluate, and justify the knowledge that we use are an important aspect of learning and development (Hofer & Bendixen,
Epistemic beliefs about what knowledge is and how we acquire knowledge have significant bearing on teaching, learning, and assessment of learning. Faculty epistemic beliefs are significant to the teaching, learning, and assessment process because they affect the learning environment that faculty create (Mason, 2010). Further, most faculty do not know about epistemic beliefs or understand how their epistemic beliefs about teaching affect their teaching style (Marra, 2005; Schraw, 2001). The type of epistemic beliefs teachers hold influences their approach to delivery of new knowledge and skills as well as the choice of assessment instruments used to measure learning (Rule & Bendixen, 2002). Specifically, if faculty have beliefs that knowledge is constantly evolving in complexity, they will choose student-centered learning strategies that will facilitate the process of knowledge revision (Mason, 2010). Faculty with the opposing belief that knowledge is simple with distinct and certain limits will tend to implement simplistic teacher-centered instruction and assessment methods that constrain student learning (Mason, 2010).

Hofer and Pintrich (2002) propose four dimensions of personal epistemology: certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing. Schommer-Aikins, (2002) suggested that within each belief domain there is a range of belief perspective from naïve to more sophisticated views (Schommer, 1990; Schommer-Aikins, 2002; Schommer-Aikins, 2004). In addition, research has shown that epistemic beliefs can change in some learning environments (Hofer & Bendixen, 2012; Paulsen & Wells, 1998; Tolhurst, 2007).

**Epistemic belief change.** For epistemic belief change to occur, certain conditions must exist (Bendixen & Feucht, 2010). A learner must perceive that their current belief is unsatisfactory, be receptive to new knowledge, make sense of the new knowledge, have the cognitive ability to apply the new knowledge, and perceive value in new knowledge (Bendixen,
Disequilibrium, or a state of fluctuation in self-directed choice (volition), occurs when considering accepting or rejecting new knowledge (Bendixen & Feucht, 2010). Teachers can use disequilibrium strategies such as problem solving to help students learn (Bendixen & Feucht, 2010; Bendixen & Rule, 2004).

The Integrative Model (IM) for epistemological development (Bendixen & Rule, 2004) hypothesizes how individuals consider and learn new knowledge. The IM illustrates a three-part cognitive mechanism of change (epistemic doubt, epistemic volition, and resolution strategies) to facilitate decision-making about new knowledge. Because of this mechanism, change to existing knowledge can occur through decisions to accept new knowledge as assimilation (replacement) or accommodation (modification), (Bendixen & Rule, 2004; Rule & Bendixen, 2010). Bendixen and Rule (2004) advocate that greater sophistication of beliefs about knowledge occurs through the mechanism of change process. Therefore, the hypothesized IM (Bendixen & Rule, 2004) shows potential for studying (a) epistemic belief change that may occur during professional development of faculty as well as (b) the innovation-decision process of DI to determine how decision-making occurs within faculty as a social group. The merging of a social change theory and constructivist learning process could enhance both theoretical perspectives and create a new platform of research investigation. Specifically, the examination of theories encapsulating epistemic belief change and innovation decisions has much potential and is relevant to the current study.

In general, the literature on epistemic belief change and assessment is minimal. Therefore, there is a need for more research to understand faculty’s epistemic beliefs about assessment of learning as individuals and as a social group. In addition, how an increase in sophistication of faculty epistemic beliefs might promote a culture of assessment (Bendixen &
Feucht, 2010; Palomba & Banta, 2014) and increase faculty contribution to institutional effectiveness through assessment (Haviland, 2009; Piascik & Bird, 2008; Sujitparapitaya, 2014).

Summary

Based on a review of the relevant literature, most studies conducted in higher education assessment have focused on identifying faculty concerns about assessment through opinion or perceptions. Additionally, most studies conducted to learn about faculty assessment behavior have focused on measuring faculty satisfaction with assessment tasks or measured faculty attitudes towards performing assessment tasks. Few studies have examined how faculty beliefs related to assessment have affected the acquisition of new knowledge about assessment (Voogt et al., 2015). Research linking faculty epistemic beliefs about classroom assessment with faculty behavior in practicing classroom assessment was not evident. Thus, the need to explore faculty epistemic beliefs about assessment of learning and factors that influence faculty decision-making when faculty are provided with new knowledge about assessment of learning. A discussion of the current study will preface the introduction of a theoretical model illustrating the hypothesized processes and variables related to faculty epistemic belief change that may occur during exploration of innovation decision-making.
The Current Study

Recommendations from a recent regional accreditation site visit to a large urban southwest community college needed to provide evidence of assessment activity and use of assessment findings for improvement. In response to the recommendations, the institution initiated a professional development campaign to promote a culture of assessment and increase faculty practice of authentic assessment. Very little attention is given in higher education research to discover how faculty conceptualize new knowledge about assessment of learning and the mechanisms of change that influence faculty epistemic beliefs. Thus, this study addresses this gap by examining epistemic belief change and innovation decision-making that occur when collaboration is used as a teaching strategy to learn innovative classroom assessment techniques in a professional development workshop.

The purpose of this convergent parallel mixed methods study was to examine the cognitive processes of epistemic change (i.e., epistemic doubt, epistemic volition, resolution strategies, affect, reciprocal causation, and metacognition) and determine the influence of two professional development teaching strategies (i.e., innovativeness and collaborative learning) on faculty epistemic beliefs, as well as how epistemic change is associated with the innovation-decision process when faculty consider adopting innovative classroom assessment strategies.

An analysis of quantitative data collected at professional development workshops (i.e., pre/posttests and surveys) and follow-up qualitative data (i.e., focus group discussions) occur in independent strands initially. Summary findings of each strand are integrated, recoded, and analyzed. Pattern analysis followed to interpret integrated findings. Final inferences were determined from overall findings to answer the research questions using a pragmatic view.
Theoretical Framework

The Integrative Model (IM) for personal epistemology development proposed by Bendixen and Rule (2004) is the primary theoretical framework for studying epistemic belief change in the current study. This study explores the IM integrated with a secondary theoretical framework of Rogers’ diffusion of innovations (Rogers, 2003). The IM framework theorizes cognitive processes not accounted for in the innovation-decision process of DI theory (Rogers, 2003).

Rogers (2003) describes how change occurs through five linear and progressive phases of the innovation-decision process (see Figure 1). In the persuasion stage, an individual demonstrates interest in the details of new innovative information, and then makes a decision about acting on the newly learned knowledge. However, a gap exists in the process of DI theory to clarify the mechanism of change that occurs between the persuasion and decision stages. The Integrative Model (IM) for personal epistemological development clarifies a complex set of cognitive processes (epistemic doubt, epistemic volition, and resolution strategies) when new knowledge is received and learned (Bendixen & Rule, 2004). The IM may address the mechanism of change gap that is unclarified in DI theory. This study will explore if the change that occurs during innovation decision-making aligns with the hypothesized IM theoretical constructs.

This new inquiry into epistemic belief change can add to the research on personal change and social change that is critical in affecting a culture of assessment at higher education institutions. For this study, I have adapted the IM to accommodate the innovation decision-making process (see Figure 2) as the descriptor of the mechanism of change that occurs within social change of DI (Rogers, 2003). In addition, I identify two independent variables of
innovativeness and collaborative learning from DI theory (Rogers, 2003) that could influence epistemic change. Thus, the Integrative Model as it applies to innovation decision-making may explain the mechanism of change that accounts for both individual and group change that occurs during social change. Specifically, the Integrative Model of Innovation Decision-Making (IM-IDM) suggests how faculty as a group and as individuals (1) consider new knowledge introduced about an innovation during professional development, (2) compare new knowledge beliefs about assessment of student learning with existing knowledge beliefs about assessment of student learning to experience epistemic doubt, (3) exercise epistemic volition to accept and act upon the new knowledge to make a behavior change, (4) and determine courses of accommodation or assimilation (resolution strategies) in their decision-making to sustain their newly adopted epistemic beliefs. Key to this study is the relationship of collaborative learning, a synergistic causative learning in groups that results when one learns from the effects of another’s enlightenment in learning (Bendixen & Rule, 2004). Literature reveals that the study of epistemic change has predominantly occurred through quantitative inquiry despite the complexities of understanding a socio-cognitive and personal epistemological phenomenology. Thus, the current study of mixed methods inquiry allows greater depth and breadth into the effects and processes of decision-making. Next, I will clarify the research questions and expectations for the current study.

**Research Questions**

The following research questions guided this study:

1. How do faculty epistemic beliefs about assessment of learning change when attending a professional development workshop series on classroom assessment techniques?

2. Which cognitive processes are apparent when faculty are making innovative decisions?
3. What effects do innovativeness and collaborative learning have on epistemic beliefs about assessment of learning when faculty experience the innovation-decision process?

Research Expectations

I expected that most faculty would:

1. Demonstrate an increase in sophisticated epistemic beliefs about assessment of learning because of the professional development workshop strategies.

2. Differentiate and express cognitive processes occurring during innovation decision-making.

Figure 1. Comparison of Theoretical Mechanisms for Change
Mechanism of Change for Innovation-Decision Process: Diffusion of Innovations (Rogers, 2003)

Figure 2. Integrative Model of Innovation Decision-Making (IM-IDM)
Research Design

I selected a mixed methods research design to utilize the combined strengths of quantitative and qualitative inquiry and obtain greater depth and breadth in results. Mixed methods designs are commonly used, and recommended, when information yielded only from one method is insufficient to answer the research questions (Morgan, 2014). This mixed methods convergent parallel design utilizes concurrent quantitative (i.e., pre/posttest and surveys) and qualitative strands of inquiry (i.e., focus group discussions) to study change in epistemic beliefs and decision-making. The focus of this study is on analyzing existing data and experiences from two cohorts of community college faculty who attended a professional development workshop series on assessment of learning. The primary unit of analysis studied are the workshop participants as an aggregate group of decision-makers. The secondary unit of analysis the individual workshop participant and their lived decision-making phenomenon.

An official solicitation was sent from the research team to the college professional development director to analyze survey data (e.g., epistemic beliefs about assessment of learning, perceived collaborative learning, and perceived innovativeness of CATs) collected for 197 participants of a three-part professional development workshop series offered in the spring and fall semesters of 2017. Analysis of workshop data would aid in exploring relationships and effects among the workshop variables. To research how decision-making and change occur, I sent a request for participation in a research focus group on classroom assessment decision-making to all workshop participants (N = 193). Individuals providing consent to participate in the focus groups (n = 39) were placed purposefully into one of four focus groups based on two criteria: series participation (i.e., spring series or fall series) and workshop completion (i.e., completion and non-completion). Quantitative results from t-tests, analysis of co-variance, and
structural equation modeling, were integrated with coded focus group discussion segments, magnitude codes, and summary themes. Integrated findings were subjected to a final pattern analysis comparing theoretical components of the current study. Interpretation of the mixed methods analysis was facilitated through visual displays in MAXQDA Pro software (MAXQDA, software for qualitative data analysis, 1989-2018). Findings were aligned with the theoretical constructs of the IM-IDM, used to answer the three research questions and determine if research expectations were met. Inferences drawn from this mixed methods study address the pragmatic interests of the institution in the current study. However, these interests (e.g., increased sophistication of epistemic beliefs about assessment of learning and increased faculty use of assessment of learning for improvement) are common pragmatic interests of all higher education institutions (Kuh et al, 2015; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009) and could have value beyond the study population.

**Definitions**

Definitions provided are from existing literature for frequently used terms throughout this dissertation. The meanings explained are for the context and scope of this study.

*Assessment:* Assessment is the “systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development” (Marchese, 1987, p. 43, as cited in Palomba & Banta, 1999). For this study, assessment means assessment of learning within the classroom to provide evidence of ability and demonstration of learning outcome achievement.

*Classroom Assessment Techniques:* An authentic assessment measure aligned with learning outcomes to directly measure student learning (Angelo & Cross, 1993).
Epistemic beliefs: Beliefs about knowledge (i.e., certainty and simplicity of knowledge) and knowing (i.e., the source of knowledge and the justification for knowing) (Hofer & Pintrich, 2002) measured on a continuum of naïve to more advanced beliefs (Bendixen & Rule, 2004).

Limitations of the Study

The following are limitations of the current study:

1. The sample used for this study has limited generalizability to larger populations—a convenience sample of secondary data was obtained to study effects of professional development on a select population of faculty attending an institution-sponsored workshop series. A criterion-based sample was determined from this population for further qualitative inquiry. The study population and research sample have representative teaching practices for full and part-time faculty at the institution within their academic units, but are not necessarily representative of all community college faculty.

2. The determination of a research sample size for this study is limited to the number of faculty representing the workshop datasets and constrained by a limited number of faculty participants needed for focus group inquiry. Not all workshop participants’ views are represented in this study. It is possible that a larger sample size would have resulted in different changes, outcomes, and inferences.

3. The sample used for this study is drawn from a large urban southwestern community college of the United States. Because of the dynamic of the community college and the population served, perceptions of assessment concepts as an innovation may not be similar or comparable with faculty at other institutions of higher education.

4. This study considers a particular form of professional development, one that is lecture-application integrated in a collaborative learning environment. It is possible that other
formats of professional development or collaborative learning among faculty will result in different changes or outcomes.

**Significance of the Study**

The brief overview of relevant literature in this chapter revealed a number of key issues surrounding assessment of student learning in higher education. This study adds to the current limited body of research on higher education social change related to assessment of learning and faculty epistemic belief change. In addition, this study focuses on three factors that have yet to be connected in the literature on higher education social change: (a) epistemic beliefs about assessment of student learning; (b) the influence of innovation and collaborative learning as faculty development strategies; and (c) the cognitive processes associated with innovative-decision-making. Results of this study may provide insight for higher education academic assessment leaders, administrators, and policy decision-makers at institutions where social change through professional development interventions are a goal for improvement in institutional assessment.
CHAPTER 2: REVIEW OF LITERATURE

College and university faculty are the primary workforce to carry out assessment activities in higher education institutions. Their role is to provide evidence of student learning (Maki, 2010; Palomba & Banta, 2014) and this responsibility can create a tenuous dynamic for institution leaders if faculty do not support assessment of student learning as a vital process of institutional effectiveness (Haviland, 2009; Lane, Lane, Rich, & Wheeling, 2014). Strategies to change assessment practice among faculty need to account for faculty as individuals and as shared decision-makers (Kezar, 2014; Van den Bossche, Segers, & Kirschner, 2006). In addition, faculty appeal to the concept of innovativeness (Rogers, 2003) and time to practice assessment processes to become adept at working with new techniques, must be considered in institution intervention and strategies to affect change (Kezar, 2014; Van den Bossche, Segers, & Kirschner, 2006). Chapter 2 presents historical considerations of assessment in higher education, conceptual and theoretical aspects supporting change in faculty epistemic beliefs and behavior related to assessment, and methodological and theoretical considerations for measuring epistemic change.

This chapter is divided into three sections. The first section begins with an overview of assessment in higher education followed by a discussion related to creating a culture of assessment at the institution level. The second section discusses belief systems foundational to conducting classroom assessment including a brief introduction to personal epistemology, extant research on epistemic beliefs and epistemic change, followed by relevant research on the effect of epistemic beliefs and assessments of learning. Finally, a discussion of cognitive processes and theoretical perspectives supports the theoretical framework for the current study.
Assessment in Higher Education

Teaching, learning, and achieving are interconnected components of the learning process and the assessment process assures that all three components aligned and supported (see Figure 4). The use of assessment processes clarify and inform all three elements of the learning process to determine the change in individuals that occur (Banta, 2002; Ewell, 2011; Huba & Freed, 2000; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009). Faculty have opinions about the purpose of assessment that often are not the same as administrators (Fuller, Henderson & Bustamante, 2015; Marrs, 2009) and resistance to assessment of learning is prevalent in a higher education environment that is predominantly top-down rather than faculty-driven (Lane, Lane, Rich, & Wheeling, 2014).

The assessment movement in higher education is associated with most of the faculty resistance expressed about assessment at colleges and universities across the United States (Ewell, 2002, 2011; Marrs, 2009). To affect change across institutions and establish a culture of assessment, most faculty shift two commonly held paradigms of teaching (Banta, 2002; Ewell, 2002, 2011; Huba & Freed, 2000; Kuh, & Ikenberry, 2009). Faculty resist expected change when there is a direct influence on their choice, workload, and demand on their non-instructional time (Haviland, 2009). A brief overview of each paradigm philosophy and the background for each shift is presented along with common faculty concerns about assessment.

The Assessment Movement and Teaching Paradigms

The need and use of assessment activities have been documented at American institutions of higher education since the 1930s (Kuh, Gonyea, & Rodriguez, 2002). Historically, primary assessment methods consisted of research, evaluation, and analytics (Astin, & Antonio, 2012) to demonstrate institutional effectiveness performance measures. Over the last 40 years,
assessment has evolved to include admissions aptitude testing, guidance and placement tests, credentialing or certification examinations, and faculty or program appraisals (Astin, & Antonio, 2012; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009). Most of these measures, however, were evaluative prior-to or post-learning in the classroom, or have indirectly measured the learning experience (Kuh, Gonyea, & Rodriguez, 2002). In the last 10 years, thinking about assessment has shifted to be a process of measuring learned ability in the classroom and higher education experience (Blumberg, 2016; Kezar, 2014b; Maki, 2010; Palomba & Banta, 2014; Snow Andrade, 2011; Wang & Hurley, 2012). “Assessment of student learning” (Suskie, 2009, p.3) is the most commonly used and accurate terminology to describe the current assessment philosophy in higher education (Ewell, 2011; Kuh, Ewell, Hutchings, Kinzie, Ikenberry, Jankowski, & Cain, 2015; Suskie, 2009). Assessment of student learning reflects the need for faculty to collect evidence of learning by means of authentic and relevant demonstrations of ability (Huba & Freed, 2000; Kuh et al, 2015; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009). Although workforce ready demonstrations of ability are expected of graduates, faculty commonly prefer to use traditional assessments tools of exams rather than innovative authentic assessment measures of real world skills (Huba & Freed, 2000; Kuh et al, 2015; Maki, 2010; Palomba & Banta, 2014; Suskie, 2009). This disparity in faculty recognition and need for adapting to a learner-centered paradigm broadly characterizes of the concerns of higher education administrators.

During the assessment movement, two dichotomous paradigms emerged. Each paradigm is distinct, yet partially explains faculty resistance to assessment (Ewell, 2002). Both paradigms (accountability vs. improvement paradigm and teacher-centered vs. learner-centered paradigm) affect the quality of learning afforded to students by faculty through their choice of teaching and
assessment methods (Behar-Horenstein & Niu, 2013; Eley, 2006). Huba and Freed (2000) explain a paradigm as an established pattern of beliefs and behavior that become accepted rules or standards of behavior. Thus, individuals feel a sense of compliance when they follow established norms of a paradigm (Olitsky, 2015). Expecting faculty to change behavior and beliefs when a new paradigm emerges can generate feelings of rule breaking for some. This can explain why there is often faculty reluctance towards new protocols and an inherent difficulty in trying to establish paradigm shifts among faculty.

**Accountability versus institutional improvement paradigm.** What has been termed the assessment movement by most assessment experts (Banta, 2002; Ewell, 2002; Huba & Freed, 2000) began in the early 1980s as mandated accountability measures by federal and state entities (Ewell, 2002). By the late 1990s, accreditation agencies developed standards for assessment of student learning in an attempt to shift the conception of assessment for accountability to an advocacy for institutional improvement (Ewell, 2011). Yet, both government and accreditation intervention have been consistently perceived by faculty in general as external oversight and, by some, as an infringement on their academic freedom (Haviland, 2009; Marrs, 2009). However, several key faculty-led organizations such as The Assessment Institute (http://assessmentinstitute.iupui.edu/) and Association for Assessment of Learning in Higher Education (http://www.aalhe.org/?) have moved to the forefront of assessment advocacy to show how accountability and institutional improvement do and should co-exist. At the same time, national agencies started to advocate for quality assessment practice across higher education institutions and to develop recommendations and protocols for assessment (Ewell, 2011).

The National Institute for Learning Outcomes Assessment (NILOA) has been the premier national research and data resource in outcomes assessment for higher education (Ewell,
NILOA’s establishment as an educational resource has broadened. Many of their reports and literature are used to educate government leaders, policy makers, and organizations external to academics. NILOA’s seminal report published in 2009, “More Than you Think, Less than We Need: Learning Outcomes Assessment in American Higher Education” is a collection of data from approximately half of all accredited institutions of higher education in the early 2000’s (Kuh & Ikenberry, 2009). Results revealed a more positive view of assessment practices that researchers anticipated with 75% of the institutions indicating that they had created and were using student learning outcomes broadly across their institutions (Kuh & Ikenberry, 2009).

Many institutional leaders realized that assessment was a constant activity of quality assurance and not a passing fad. Subsequently institution leaders responded by investing in assessment infrastructure, resources, and policy change (Ewell, 2002). Unfortunately, faculty who were less involved in accreditation compliance assumed an increase in assessment activity was a temporary reaction and assessment demands would trickle off after a site visit with little or no influence on their teaching (Ewell, 2002; Haviland, 2009, Marrs, 2009). Thus, the disparity in perspectives between administrators and faculty continues to be one of the greatest barriers to completing the full process of assessment for institutional improvement at many higher education institutions. (Fuller, Henderson, & Bustamante, 2015; Maki, 2010; Palomba & Banta, 2014).

Faculty’s perspective on the role and purpose of teaching has influenced their perspective on the purpose of assessment. For example, those that predominantly saw assessment as a form of accountability also shared traditional teaching-centered conceptions about teaching (Ewell, 2002). The following sections review how changes in academic paradigms have influenced faculty teaching practice as well as their understanding and use of assessment.
Table 1. Comparison of Teacher-Centered and Learner-Centered Paradigms

<table>
<thead>
<tr>
<th>Teacher-Centered Paradigm</th>
<th>Learner-Centered Paradigm</th>
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<tbody>
<tr>
<td>Knowledge is transmitted from professor to students.</td>
<td>Students construct knowledge through synthesizing information and integrating it with other skills</td>
</tr>
<tr>
<td>Students passively receive information.</td>
<td>Students are actively involved.</td>
</tr>
<tr>
<td>Emphasis is on acquisition of knowledge outside the context in which it will be used.</td>
<td>Emphasis is on using and communicating knowledge effectively to address enduring and emerging issues and problems in real-life contexts.</td>
</tr>
<tr>
<td>Professor’s role is to be primary information giver and primary evaluator.</td>
<td>Professor and students evaluate learning together.</td>
</tr>
<tr>
<td>Teaching and assessing are separate.</td>
<td>Teaching and assessing are intertwined.</td>
</tr>
<tr>
<td>Assessment is used to monitor learning.</td>
<td>Assessment is used to promote and diagnose learning.</td>
</tr>
<tr>
<td>Emphasis is on right answers.</td>
<td>Emphasis is on generating better questions and learning from errors.</td>
</tr>
<tr>
<td>Desired learning is assessed indirectly with objectively scored tests.</td>
<td>Desired learning is assessed directly through papers, projects, performances, portfolios, and the like.</td>
</tr>
<tr>
<td>Focus is on a single discipline.</td>
<td>Approach is compatible with interdisciplinary investigation.</td>
</tr>
<tr>
<td>Culture is competitive and individualistic.</td>
<td>Culture is cooperative, collaborative, and supportive.</td>
</tr>
<tr>
<td>Only students are viewed as learners.</td>
<td>Professor and students learn together.</td>
</tr>
</tbody>
</table>


**Teacher-centered versus learner centered paradigm.** Teachers have formed certain conceptions about teaching that include the role of the teacher, teaching style, and the methods used to teach (Eley, 2006). Initial empirical studies of faculty conceptions of teaching (Kember, 1997; Kember & Kwan, 2000; Murray & Macdonald, 1997; Samuelowicz & Brain, 1992; Trigwell, Prosser, & Taylor, 1994; Trigwell & Prosser, 1996a, 1996b) resulted in a cumulative categorization of beliefs divided into two paradigms of teaching practice, traditional teacher centered and learner-centered (see Table 1). The teacher-centered instruction process has the teacher in the active role as deliverer or transmitter of knowledge and the student in the passive role receiving and processing knowledge (King & Kitchener, 1994). Higher education still predominantly supports and maintains a traditionalist concept of learning (Hsu & Malkin, 2011).
Learner-centered strategies of instruction focus on concepts about how best to help students acquire and process the new knowledge (Gibbs & Coffey, 2004). The difference in these two approaches is learner-centered instruction supports in-depth and varied learning with emphasis on helping learners to critically think and make sense of information. Teacher-centered instruction is associated with providing information on a surface level that mostly fosters learner rote memorization and recall of facts (Gibbs & Coffey, 2004). Most college instructors can attribute their style and instruction approach to how they were trained in their formal education and most educators who teach in post-secondary education have little or no formal education in learning development, teaching methodology, or assessment (Mundy, Kupczynski, Ellis, & Salgado, 2012; Reybold, Flores, & Riojas-Cortez, 2006).

**Learner-centered assessment.** Huba and Freed (2000) describe learner-centered assessment as “an activity, assigned by the professor that yields comprehensive information for analyzing, discussing, and judging a learner’s performance on valued abilities and skills” (p. 12). More importantly, Webber (2012) emphasizes that learner-centered assessment is used to inform and reform the learning process, not just report the occurrence of learning. Azis (2015) differentiates this paradigm from an understanding of the purpose and use of assessment and proposes a parallel paradigm of assessment of learning (accountability focused and teacher-centered approach) to assessment for learning (improvement focused and learner-centered).

Another difference between these dichotomous paradigms is that traditional assessment predominantly uses knowledge-based testing measures and learner-centered assessment involves the use of direct observation of a student’s ability in the classroom (Webber, 2012). Increased research in the fields of social cognitive theory (Bandura, 1991; Pajares, 1996) and epistemic cognition (Baxter Magolda, 1992; Hofer, 2001; Kitchener, 1983) helped facilitate learner-
centered assessment by emphasizing the inclusion of behavioral, social/environmental, and personal factors into higher education assessment measures (Kuh, Gonyea, & Rodriguez, 2002). In fact, the desire to know if assessment measures were authentic indicators of learning and the creation of new ways to assess learning have been attributed to promoting the learner-centered paradigm (Kuh, Gonyea, & Rodriguez, 2002).

Brown asserts that all aspects of pedagogy (e.g., teaching, learning, curriculum, assessment, teacher efficacy) are affected by a teacher’s conceptions about student behavior and performance (2004; 2006). In addition, conceptions are strongly tied to shared cultural and social phenomenon (Brown, 2004, 2006, 2008; Brown & Hirschfeld, 2008; Brown & Michaelides, 2011; Remesal & Brown, 2015), and intervention plans that incorporate social and collaborative strategies have resulted in significant changes (Azis, 2015).

Although the majority of research conducted on learner-centered practice focuses on changing faculty beliefs, researchers have also investigated innovative learning approaches (Errington, 2004; Jogi, Karu, & Krabi, 2015), teaching within specific academic disciplines (Neumann, Parry & Becher, 2002; Olitsky, 2015; Stes, Coertjens, & Van Petegem, 2010), learning facilitated by new first time faculty (Denecker, 2014; Norton, Aiyegbayo, Harrington, Elander, & Reddy, 2010), and learning that occurs within professions (Behar-Horenstein & Niu, 2013; Colley, 2012). In analyzing these studies, all were able to identify faculty with teacher-centered paradigms and measure significant belief change, or observe behavior change through implementation of constructivist learner-centered interventions.

In sum, the assessment movement has identified how the changing of academic paradigms has effected faculty and their teaching practice (Ewell, 2011; Huba & Freed, 2000) and faculty understanding of the purpose and use of assessment (Olitsky, 2015). The literature
reviewed supports that the academic paradigms have shifted but not completely transitioned. Research on faculty beliefs and practice of learner-centered assessment is limited and more research is needed to facilitate greater transition of faculty assessment practices. The last segment of this section will focus on the literature that supports faculty change to establish a positive culture of assessment at institutions. An institutional perspective may identify ways to address promoting a paradigm shift to learner-centered assessment practices through institution-wide strategies.

**Faculty Change and Creating a Culture of Assessment**

Snow Andrade (2011) explains a culture of assessment as an investment in beliefs that unify members of an institution and build trust. Faculty concerns about assessment center on a lack of trust and frustration with college administration. Typically, policies on assessment are created by administration without consideration of the effect on faculty (Haviland, 2009b). Faculty have also expressed frustration with being required to complete assessment tasks without being given clear directions on the purpose or procedures for completing the tasks (Daniels, Poth, Papile & Hutchison, 2014; Emil & Cress, 2014; Sujitparapitaya, 2014). Similarly, faculty knowledge of assessment, ability to perform assessment tasks, and incentives to conduct assessment have not always been provided or available (MacDonald, Williams, Lazowski, Horst, & Barron, 2014; Marrs, 2009; Sujitparapitaya, 2014). In addition, faculty do not take the opportunity for training in assessment when offered such activities (Daniels, Poth, Papile & Hutchison, 2014; Emil & Cress, 2014; Marrs, 2009; MacDonald, Williams, Lazowski, Horst, & Barron, 2014; Sujitparapitaya, 2014). As well, Piascik and Bird (2008) found faculty issues with time as a barrier in two different contexts: time to train faculty in assessment processes, and time that faculty need to complete assessment processes. The large number of faculty who lack
knowledge of current assessment techniques due to insufficient training of faculty in assessment practices and the need to plan for continual training resources was a significant barrier, but administration not recognizing the need for faculty training resources had greater effect as a barrier (Piascik & Bird, 2008).

Most of the research that has been conducted on culture of assessment has been exploratory by surveying or interviewing faculty about their opinions of assessment (Norton, Norton, & Shannon, 2013; Piascik & Bird, 2008; Wang & Hurley, 2012) and primarily focused on revealing barriers to conducting assessment (Fuller, Henderson, & Bustamante, 2015). Wang and Hurley (2012) found in their survey study that faculty willingness to engage in assessment was significantly related to faculty perceptions of assessment as a scholarly activity. If faculty perceived assessment as a beneficial/useful activity supporting teaching, learning, and assessment, they were more willing to participate in assessment activities on campus (Wang & Hurley, 2012). This link between understanding of purpose and engagement is important and further studies of causality are needed to create better methods to foster culture change. Few empirical articles are found on what causes a culture of assessment. In fact, Kezar (2013) adds, “generally, the literature produced on assessment was not grounded in cultural theory (or any theory)… future research needs to develop a clear definition and conceptual framework that distinguishes between organizational culture/climate and leadership based on existing theories” (Kezar, 2013a, p. 197).

The literature just reviewed reveals the important role of changing paradigms that affect teaching, learning, and assessment. Empirical evidence supports facilitating faculty change to a learner-centered paradigm to improve both the classroom-learning environment and institutional effectiveness. Assessment experts explain paradigm shifts and creating a culture of assessment
can be facilitated in various ways (a) increasing faculty knowledge about learner-centered assessment; (b) reducing barriers to implementation of assessment activities; and (c) creating a collaborative environment for assessment on campus. Further, a collaborative effort between institution leadership, administration, faculty and staff would create a shared culture of assessment and have a greater chance of promoting a paradigm shift towards learner-centered practices. However, the literature reveals a gap in understanding how faculty belief change occurs and contributes to a culture of assessment. Therefore, a theoretical approach to studying belief change in assessment of learning could provide a pragmatic approach to establishing a culture of assessment.

Social Change Strategies

Traditional social change efforts have used the strategy of mass education efforts and then targeted specific social groups to determine change over time. Garland, Bickman, and Chorpita (2010) admit that institutional change is complex when there are multiple decision-makers that need to be persuaded to change. Change strategies need to account for social hierarchies (Kezar & Eckel, 2002a), culture (Kezar & Eckel, 2002b), and values of the system (Aarons, Hurlburt, & Horwitz, 2011), as well as multiple levels of change or change that needs to occur at different intervals (Rogers, 2003).

Faculty are independent decision-makers that also need recognition as part of a very large decision-making body. Most of the research reviewed involves changing faculty attitudes or behavior through professional development strategies including the use of collaborative learning. The emphasis of the studies are primarily focused on measuring personal change (Dunn, Airola, & Garrison, 2013; Emo, 2015; Estepp, Roberts, & Carter, 2012; Hardre, 2012). On a macro level, social cognitive theories have recently gained greater prevalence in higher education
research designs because of their capacity to address large and diverse populations as learners in need of change (Kezar, 2014). Next, an overview of how social cognitive theories have been integrated into faculty development models reveals effective strategies for faculty belief change as well as gaps in understanding how belief change occurs and how belief change is achieved.

**Social Change and Faculty Development**

Bauer, Festner, Gruber, Harteis, and Heid (2004) posed that informal learning in the workplace mostly consists of pragmatic and situated learning that helps an employee meet work demands of organizational expectations. Several other studies on the workplace as a learning environment have addressed aspects of creating and using knowledge (Fuller, Unwin, Felsted, Jewson & Kakavelakis, 2007), personal epistemic agency (Smith, 2006), transformative change (Yorks & Sharoff, 2001), cognitive learning theory (Illeris, 2003), and educator reliance on epistemic agency (Smith, 2006). For example, Stromso and Braten (2011b) found that teaching effectiveness and learning achievement were enhanced when the workplace offered professional development on site.

Many institutions of higher education establish professional development centers to support educators in their role of teaching and offer courses in teaching methodology, learning technology, course management, and curriculum design (Mundy, Kupczynski, Ellis, & Salgado, 2012; Shagrir, 2011; Stes, Coertjens, & Van Petegem, 2010). Professional development courses have been created specifically to enhance instructional practices (Ambrosino & Peel, 2011; Boyle, While & Boyle, 2004; Gibbs & Coffey, 2004; Gonzales, Pickett, Hupert, & Martin, 2002) or promote teacher self-efficacy beliefs (Postareff, Lindblom-Ylanne, & Nevgi, 2007; Postareff, Parpala, & Lindblom-Ylanne, 2015; Singh, Grave, Ganjiwale, Supe, Burdick, & Van Der Vleuten, 2013). Several institutions have been successful at using faculty development
strategies to promote a culture of assessment and educate faculty, administrators, and staff on assessment process (Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011; Offerdahl & Tomanek, 2011). Palomba and Banta (2014) declare that a lack of knowledge in assessment processes can deter faculty from engaging in assessment activities. This corresponds with 64% of institutions responding to the 2014 National Institute for Learning Outcomes Assessment report that indicated that the number one factor needed to “move assessment processes forward” (Kuh, Jankowski, Ikenberry, & Kinzie, 2014, p. 11) was more professional training in assessment for faculty and staff.

**Diffusion of Innovations**

The study of change that occurs in broad social populations must consider and account for several social characteristics and structural characteristics. Rogers’ theory on diffusion of innovations (2003) has been used as a framework for over 30 years within many disciplines (e.g., political science, public health, communications, history, economics, technology, and education) to study the process of diffusion of information and adoption of an intervention with attributes of innovativeness (Sahin, 2006). According to Kezar (2014), diffusion of innovations (DI) is a foundational theory and the most commonly used intervention model for studying change in social groups, including the study of higher education faculty adoption of assessment activities (Blumberg, 2016; Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011).

There are four main elements of the diffusion process within DI theory: social system, communication channels, time, and innovation (see Figure 3). Rogers defends, “any process of change must be characterized by these concepts and must account for them in some formula” (Rogers, 2003, p. 20). The core of this theory focuses on influencing individuals to adopt an innovation intervention (Rogers, 2003). Rogers (2003) defines an innovation as an “idea,
practice, or object that is perceived as new by an individual or other unit of adoption” (p. 12). DI theory outlines how a framework of diffusion + innovation = adoption can be used as a faculty development change strategy.

**Figure 3. Five Stages of the Innovation-Decision Process in DI Theory (Rogers, 2003)**

**Communication channels.** Rogers (2003) defines communication as “a process in which participants create and share information with one another in order to reach a mutual understanding” (p. 5). Typically, individuals listen to and respect the subjective opinions of their peers over valid, scientific research evidence (Rogers, 2003). Socio-metrics research has shown that individuals will make decisions based upon the valued experience of peers within their social system over experts within a given field (Rogers, 2003). The literature reveals peer influence and collaboration as vital instruction strategies for changing beliefs and behavior (Miller, Klotz, & Eckholdt, 1998; Puska et al., 1986; Valente et al., 2002), and instruction using collaboration as a vital diffusion mechanism within social systems (Rogers, 2003; Kezar, 2014; Kezar & Eckel, 2002a).
**Collaborative learning.** Collaborative learning is not new to higher education and has been used liberally in leadership training (Quinlan, & Åkerlind, 2000) to improve collegiality (King & Moore, 2013; Van Waes, Van den Bossche, Moolenaar, De Maeyer, & Van Petegem, 2015) and to enhance teaching skills (Hill, La Kim, & Lagueux, 2007). Studies of faculty development with collaborative learning environments indicate greater faculty motivation and commitment to teaching (Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011; MacDonald, Williams, Lazowski, Horst, & Barron, 2014; Sujitparapitaya, 2014). Faculty interest in collaborative learning stems primarily from peer socialization and using fellow faculty as a support system in decision-making (King, & Moore, 2013). Rogers (2003) explains this phenomenon as interconnectedness in social systems and clarifies interconnectedness as the personal links formed among individuals.

Research conducted by Olitsky (2015) has focused on the change that occurs in collaborative learning groups during professional development training and finds that the collaborative learning process can create group efficacy and help resolve cognitive dissonance. Olitsky describes cognitive dissonance as a process of uncertainty and wavering between doubt and self-efficacy. Olitsky (2015) also noted that cognitive dissonance might be more deep-rooted in some faculty more than others may; therefore, belief and behavior change need to be facilitated over time. In addition, Olitsky (2015) found that group efficacy reduced faculty disengagement from collaborative groups and promoted individual contributions to group development. Van den Bossche, Segers, and Kirschner (2006) posit that mutually shared cognition occurs in collaborative learning groups. To clarify, shared understanding results from the diversity of group members’ experiences, values, and knowledge. Further, Van den Bossche, Segers, and Kirschner contend that this process contributes to increased problem solving ability.
because of the greater number of possible perspectives, strategies, and solutions that an individual can provide (2006). Thus collaborative learning as a diffusion mechanism creates a positive environment for faculty change in beliefs and behavior regarding teaching and assessment of learning.

**Time.** Rogers (2003) indicates that many research studies do not allow sufficient time for change to occur. Therefore, with sufficient time, certain factors such as mental processes, autonomy of choice, and trends, can be accounted for when manifested. DI theory accounts for time in three different aspects (a) a process for decision-making (innovation-decision process); (b) a way to classify individuals based on the length of time to make their decision (innovativeness or adopter categorization); and (c) the number of individuals to adopt an innovation within a span of time (rate of adoption). These facets of time align with faculty development strategies of segmented exposure new knowledge allowing for faculty decision-making based on experience using the new knowledge.

**Innovation.** There are five characteristics which Rogers (2003) terms “attributes of innovations” (p. 15-16): “relative advantage, compatibility, complexity, trialability, and observability”. Measuring these five attributes can provide insight into the value and importance an individual places on new concepts. Each of these attributes is clarified as to their roll in adoption.

**Relative advantage.** The degree to which an innovation is perceived as better than the idea it supersedes, the greater the perceived relative advantage of an innovation, and the more rapid its rate of adoption will be (Rogers, 2003, p. 15). Economic factors and status are relative dimensions that an individual must weigh for personal advantage before choosing to adopt an innovation.
**Compatibility.** The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible (Rogers, 2003, p. 15).

**Complexity.** The degree to which an innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings (Rogers, 2003, p. 16).

**Trialability.** The degree to which an innovation may be experimented with on a limited basis. An innovation that a person can try represents less uncertainty to the individual who is considering it for adoption, as it is possible to learn by doing (Rogers, 2003, p. 16).

**Observability.** The degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt (Rogers, 2003, p. 16).

Rogers (2003) explains that greater ratings in each of these attributes (with less perception of complexity) favor more rapid adoption rates. Between the five attributes, relative advantage has been shown to be the strongest predictor of adoption rate for an innovation (Sahin, 2006). DI theory provides a framework that accounts for exposure to an innovation and communication mechanism to influence a person’s decision to adopt an innovation. However, literature on the innovation-decision process of DI theory varies as to how decision-making occurs and what is attributed to change associated with decisions formed from new knowledge.
The innovation-decision process is described and gaps revealed that are essential to the study of faculty beliefs.

**Innovation-decision process.** The innovation-decision process includes five stages: knowledge, persuasion, decision, implementation, and confirmation (see Figure 3). Rogers (2003) explains the innovation-decision process as:

The process through which an individual (or other decision-making unit) passes from first knowledge of an innovation, to the formation of an attitude toward the innovation, to a decision to adopt or reject, to implementation and use of the new idea, and then to confirmation of this decision (p. 20).

In the framework, communication about an innovation is reinforced constantly at each stage of the process. Prior conditions and characteristics of the social structure can manifest at the knowledge stage; perceived characteristics of the innovation can effect and persuade; initial decisions can be made to adopt or reject; then after implementation of an innovation, continued decisions or later decisions can be made at the confirmation stage (Sahin, 2006).

**Adoption decisions.** Rogers (2003) contends that most individuals use adequate time to consider adoption decisions. In DI theory, the product of the innovation-decision process yields several decision types: adoption, continued adoption, adoption/re-invention, later adoption, discontinuance, rejection, and continued rejection. Adoption indicates that individuals have implemented the innovation and are “making full-use of the innovation” (Rogers, 2003, p. 177). Continued adoption is measured as sustained use of the innovation across a span of time. An adoption/re-invention decision indicates that individuals have implemented aspects of the innovation, modified the innovation, and implemented a modified version. Later adopters implement aspects of the innovation, but are still practicing and considering the innovation. In
addition, late adopters are less likely to recognize attributes of innovations (Sahin, 2006, Rogers, 2003). Individuals may also decide to discontinue use of an innovation they implemented or reject the innovation altogether. In sum, the literature reveals that adoption decisions are often self-reported and adoption decisions do not always correlate with sustained behavior (Kezar, 2014; Sahin, 2006). Few studies use a theoretical approach in the design of professional development to influence faculty beliefs and behaviors in assessment. Two extant studies are discussed as examples of professional development designs employed to affect change in faculty knowledge and behavior leading to an institutional culture of assessment.

**Innovation and assessment methods.** Although DI theory has been used to frame faculty development courses on assessment of learning, the literature reveals there is no consistency in model designs or innovation. Model designs vary in length (1 day to multi-sessions over several months) and innovation strategies (e.g., learner-centered activities, template use, authentic assessment techniques, and standardized assessment measures). A review of literature on professional development DI designs reveals several issues and gaps in understanding the use of innovation is used in professional development to increase faculty knowledge and behavior of assessment processes.

Blumberg (2016) employed a one-day faculty development workshop to teach learner-centered teaching strategies as an innovative approach to changing faculty paradigms from teacher centered to learner-centered teaching practices. The learner-centered strategies focused on constructivist activities to teach and measure student learning. Self-report of teaching practices was measured along a continuum of four stages: instructor-centered, lower level of transitioning, higher level of transitioning, and learning-centered. Fourteen percent of the workshop participants reported consistently using learner-centered teaching strategies, whereas
five percent rejected the strategies. The majority of participants (77%) were in transitioning stages. However, Blumberg did not differentiate which participants were at the lower levels or higher levels of transitioning. Instead, Blumberg focused her results on the predictive nature of DI theory regarding faculty adoption of an innovation. Rogers (2003) hypothesizes that participant adoption will consistently follow a normal distribution with few outliers. Blumberg acknowledges several limitations in her study but recommends observation of faculty teaching and review of teaching materials to validate self-reported measures.

Haviland, Shin, and Turley (2010) used DI theory (Rogers, 2003) as a framework to design a four-part professional development workshop series on program assessment. Various program assessment activities were presented as innovative and the workshop goal was to effect faculty understanding, self-confidence, and attitudes towards performing program assessment. Workshop participants worked collaboratively on designing various program assessment activities including: designing program learning outcomes, determining appropriate evidence for assessing program outcomes, creating rubrics for signature assignments, and strategies for interpreting and using student performance data (Haviland, Shin, & Turley, 2010). The program assessment activities were found to be an effective innovation and faculty showed increased knowledge in the role they played in assessment, skills applied to conducting assessment activities, as well as confidence and attitudes while conducting assessment (Haviland, Shin, & Turley, 2010).

In determining the effect of innovation on faculty understanding and confidence, both paired t tests and single group MANOVA with repeated measures failed to show statistical significance although most individual test scores did show increased knowledge and understanding of the innovation to some degree (Haviland, Shin, & Turley, 2010). Individual
session evaluations were also positive ranging from 70-90% confidence in ability and faculty expressed in interviews an increased understanding and confidence in the program assessment system (Haviland, Shin, & Turley, 2010). This disparity in measurement findings could be due to inflatability of self-report measures. Although the workshop design emulated the theoretical principles of DI theory (Rogers, 2003) and participants indicated increased understanding by self-report, the lack of statistically significant results in increased knowledge leaves one to question whether the knowledge collection measure aligned with the theoretical principles or can be attributed to a small convenience sample. In a one-year follow-up study by Haviland, Turley, and Shin (2011), findings indicate not only a sustained but improved effect on faculty understanding, confidence, and attitudes. Faculty concerns regarding increased demand on their time to perform assessment were not found in the follow-up study, although participants indicated greater efficiency in performing assessment tasks (Haviland, Turley, & Shin, 2011).

A primary limitation of the previously mentioned studies (Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011) are data derived from a small convenience sample that was not a stratified representation of faculty across the institution. A question still exists whether similar results can be achieved at other institutions of higher education. In addition, limited discussion on how results support the essential components of DI theory was not found in either study. Greater emphasis could have been given to determining the degree of innovativeness faculty associated with the workshop content. It is unclear how the innovativeness of the workshop strategy reduced faculty concerns of time allocated to assessment and differentiating which tasks faculty found more challenging or taxing on their time. It is also important to consider whether an increase in sample population size could in fact address these limitations.
**Strengths and weaknesses of DI theory.** The literature reveals numerous studies that have successfully used DI theory as a framework to identify predictive factors of adoption and identify barriers to adopting an innovation (Sahin, 2006; Wisdom, Chor, Hoagwood, & Horwitz, 2014). However, Surry (1997) examines DI claiming that it is not a comprehensive theory but instead a compilation of four separate, distinct conceptual systems: the innovation-decision process, individual innovativeness, rate of adoption, and perceived attributes. For this reason, several research studies fail to make use of the entire theoretical model, which weakens the essential validity of DI. In addition, very little research was found that focuses on determining how the innovation-decision process occurs.

This section of the review has identified DI theory (Rogers, 2003) as an effective framework for various change strategies, is pertinent to the study of change in faculty beliefs and behavior, and predicts a process of decision-making about innovation adoption. However, weaknesses in DI reveal a significant gap in understanding mechanisms of change in the innovation-decision process. Next, a review of belief systems foundational to learning and behavior change reveals a theoretical model for study of the innovation-decision process in DI.

**Belief Constructs Foundational to Teaching, Learning, and Assessment**

In reviewing the literature on belief constructs, there is a broad level of diversity in the use and meaning of terms related to beliefs. Terms range from faculty concerns (e.g., views, opinions, impressions, observations, and perceptions) to faculty beliefs (e.g., teaching beliefs, teaching ability beliefs, epistemological beliefs, epistemic beliefs, and conceptions). However, Hofer and Bendixen (2012) clarify the development of beliefs about knowledge and knowing as personal epistemology. The core content of beliefs is knowledge and Bahcivan (2016) describes knowledge as ideas linked together through personal meaning. Bahcivan further explains that as
we age and acquire more knowledge we organize our beliefs into a hierarchal system of value and importance. Therefore, the attempt to change such belief systems is a complex task (Bahcivan, 2016). The following section presents an overview of personal epistemology followed by a discussion of epistemic beliefs and factors related to epistemic belief change. Next, empirical intervention studies related to teaching, learning, and assessment support theories of epistemic belief change. Last, discussion explores theoretical models to study the role of epistemic beliefs in the innovation-decision process.

**Personal Epistemology**

As learners, we acquire knowledge from various sources and in different contexts (Cano, 2005; Hofer & Pintrich, 1997). How we perceive and process that knowledge is significant because old knowledge can influence our perception of any new knowledge we acquire (Hofer, 2001; Hofer & Pintrich, 2002). Similarly, our personal epistemology (Hofer 2001; Hofer & Pintrich, 2002) allows us to give individually unique perspectives to new knowledge by assigning personal value to the knowledge and then judging its usefulness (Cavallo, Rozman, Blickenstaff, & Walker, 2003). The value we assign to the new knowledge determines where we store the knowledge in memory for identification and retrieval later on when we need to recall and use the information (Cavallo, Rozman, Blickenstaff, & Walker, 2003).

Hofer and Pintrich (2002) propose that personal epistemology includes four dimensions that encompass beliefs about knowledge (i.e., certainty and simplicity of knowledge) and knowing (i.e., the source of knowledge and the justification for knowing). The following describes each of the four dimensions and illustrates both ends of a belief continuum (i.e., naïve to more advanced beliefs):
1) **Certainty of knowledge** - Absolute truth exists with certainty as compared to the belief that knowledge is tentative and evolving.

2) **Simplicity of knowledge.** Knowledge is a simple accumulation of discrete facts in contrast to the belief that knowledge is complex, and made up of highly integrated concepts.

3) **Source of knowledge.** Knowledge originates outside the self and resides in external authoritative sources as compared to the belief that the self is a knower with the ability to construct knowledge in interaction with others.

4) **Justification for knowing.** How individuals evaluate knowledge claims, ranging from the belief that knowledge can be justified based on what feels right, first-hand experience, authority, etc. to the belief that rules of inquiry or reason should be used, that one must personally evaluate and integrate sources, and critically assess expert opinions (Hofer, 2001).

The origins of personal epistemology have come from various research perspectives: epistemological beliefs of adult learners (Perry, 1970), epistemological patterns in women (Belenky, Clinchy, Goldberger, & Tarule, 1986), knowledge and comprehension (Schommer, 1990), epistemological reflection (Baxter Magolda, 1992), epistemology and argumentative reasoning (Kuhn, 1991), and reflective judgment (King & Kitchener, 1994). Our personal epistemology provides us with the reasons, value, justification, and motivations to guide our thoughts and behavior (Hofer & Pintrich, 2002).

As was stated previously, each belief dimension comprising personal epistemology is measured as a spectrum of beliefs from naïve, simplistic beliefs to sophisticated, complex beliefs (Schommer, 1990; Schommer-Aikins, 2002; Schommer-Aikins, 2004). Each belief domain is
considered as relatively independent and beliefs can change with learning and development (Buehl & Alexander, 2005). Schommer (1990) developed an early measure of epistemic beliefs, which was subjected to tests of validity and modifications to further refine its dimensions (Schraw, Bendixen, & Dunkle, 2002). Work that is more recent has led to the design of new instruments (Braten, Gil, Stromso, & Vidal-Abarca, 2009; Buehl & Alexander, 2002; Hofer, 2000). Braten, Gil, Stromso, and Vidal-Abarca (2009) created the Topic-Specific Epistemic Beliefs Questionnaire (TSEBQ) based on Hofer’s dimensionality model (Hofer & Pintrich, 2002). The TSEBQ has emerged as a highly valid and reliable measure that is widely used because of its adaptability to subject content (Braten, Gil, Stromso, & Vidal-Abarca, 2009; Stromso & Braten, 2011a; Stromso, Braten, & Britt, 2011).

The measurement of epistemic beliefs is of importance to educators who have the primary role in facilitating epistemological development (Hofer & Bendixen, 2012; Schraw, 2013). Research has shown that epistemological development does occur in certain learning environments (Paulsen & Wells, 1998; Tolhurst, 2007) and epistemic beliefs can change with shifts from naïve thinking to more sophisticated thinking (Hofer & Pintrich, 1997, 2002; Schraw, 2013; Schraw, Dunkle, & Bendixen, 1995). Empirical studies on personal epistemology/epistemic belief change have shown significant changes in cognitive processing when students were taught to use higher more constructivist concepts (Hofer, 2004; Schraw, Dunkle, & Bendixen, 1995) including critical thinking (Nussbaum & Bendixen, 2003; Richter & Schmid, 2010), reasoning (Bendixen, Schraw, & Dunkle, 1998), and problem-solving (Angeli & Valanides, 2012). In fact, some studies have been able to demonstrate predictive results between epistemic beliefs, learning processes, and learning outcomes (Braten, Britt, Stromso, & Rouet, 2011; Braten & Strømsø, 2006).
Findings from several studies indicate faculty epistemic beliefs evolve throughout the stages of personal careers and teaching experience (Bendixen & Corkill, 2011; de Vries, van de Griff, and Jansen, 2014; Jorum, 2007; Olafson, Schraw & Vander Veldt, 2010). In fact, Bendixen and Corkill (2011) suggest that epistemic belief change can occur in the most experienced teachers. Ecclestone and Pryor (2003) found strong ties between faculty epistemic beliefs and their teaching practices when observing an increase in sophistication of epistemic beliefs with adoption of new teaching strategies that include authentic assessment of student learning. However, some faculty were resistant to adopting new teaching strategies perceiving a change in epistemic beliefs and newly adopted beliefs would affect their teaching identity (Ecclestone & Pryor, 2003). The concept that professional development’s role was to change teaching identity through epistemic change was not suggested. However, this could be included in a research design to study faculty epistemic change that occurs during professional development and be a valuable direction for future research.

Research also shows how teachers’ knowledge of their own epistemic beliefs affect their choice of teaching strategies, and how their choices affect their learners (Brownlee, Walker, Lennox, Exley, & Pearce, 2009; Chan, 2011; Chai, Teo, & Lee, 2010). Schraw (2001) has stated that there are “four ways that our expanding knowledge of epistemological beliefs can change education. This would include helping teachers to understand their own beliefs, understanding factors that affect students’ beliefs, promoting a critical thinking pedagogy, and introducing conceptual change into the classroom” (p. 461). Professional development teaching strategies can provide faculty the opportunity to learn about and enhance their own epistemic beliefs as well as enhance the epistemic beliefs of their students (Brownlee, Schraw, & Berthelsen, 2011).

The focus of this section of the review has been on exploring the connection between
epistemic beliefs and teacher learning to determine ways to change faculty epistemic beliefs. Understanding how faculty can continue to learn and evolve in their role as teachers is essential to the research community and learning institutions and has pragmatic value. Research on epistemic belief change that occurs in higher education faculty and faculty change from a teacher-centered perspective to a learner-centered teaching perspective was sparse. This disparity in the research indicates a need for greater focus in this area. Since the findings in the literature show a significant link between epistemic beliefs and the teaching/learning process, and research was found that shows how learning affects epistemic belief change, these findings can support future research on the instruction of faculty and faculty epistemic belief change. Understanding how epistemic belief change occurs is essential to the framework of this study.

**Epistemic Belief Change**

Hofer and Pintrich (1997) postulate that epistemic belief change occurs because of a cognitive process called “disequilibration” (p. 123). Further, disequilibration can occur when new knowledge does not coincide with old knowledge; individuals apply a process of questioning or confirming existing knowledge concepts in the presence of new knowledge (Hofer & Pintrich, 1997). Olitsky (2015) describes a similar process of cognitive dissonance as a wavering process in accepting or rejecting new knowledge in part or whole. In fact, cognitive dissonance can mean, “questioning one’s beliefs about knowledge and knowing” (Bendixen & Feucht, 2010, p. 99). Conceptual change theory embraces disequilibration and cognitive dissonance processes (Posner, Strike, Hewson, & Gertzog, 1982) and is integral to understanding epistemic belief change. Bendixen (2002) summarizes conceptual change theory associated with epistemic belief change as (a) a sense of dissatisfaction with a current belief; (b) receptiveness and willingness to make sense of new knowledge; (c) cognitive ability to use new knowledge;
and (d) new knowledge that can withstand challenge, resulting in learning. Most important, learning can be designed to promote disequilibration or cognitive dissonance within learners through higher cognitive learning processes of problem-solving and reasoning activities (Rule & Bendixen, 2010). Structuring knowledge delivery and learning acknowledgment can help educators realize if new knowledge has fostered change in learners’ epistemic beliefs about knowledge and knowing (Bendixen & Feucht, 2010).

An integrative model (IM) for personal epistemology development proposed by Bendixen and Rule (2004) helps to illustrate the theoretical mechanism of change that occurs when new knowledge is received (see Figure 5). Teacher recognition of IM was hypothesized to facilitate epistemological growth in primary education learners. However, Bendixen and Rule (2004) indicate that the design is not exclusive to young learners and the hypothesized model has not yet been fully studied. Further, its use as a generalizable model shows potential for studying epistemic belief change in a broader range of learners and learning environments (Bendixen & Rule, 2004). As faculty evolve in their careers, their reasons for incorporating new knowledge into their teaching and choices of assessment strategies change. Therefore, the use of the IM as a framework for the current study is relevant to understand how epistemic change occurs during faculty decision-making about assessment strategies.

The IM proposes an integrated system of epistemology development that involves a change mechanism, reciprocal causation, belief dimensions, meta-cognition, affect, environment, and equilibration (Bendixen & Rule, 2004). The result of these combined processes can lead to advanced beliefs conducive to increased learning, and advanced abilities. A brief description of key IM components follows.
Figure 4. Integrative Model (IM) for Personal Epistemology Development.

Note. As published in Bendixen and Rule (2004) with the addition of the personal epistemology multiplier (Rule, 2003)

**Epistemic beliefs and cognitive ability.** The four dimensions of epistemic beliefs as proposed by Hofer and Pintrich (2002) are certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing. Each of these belief domains can change when new knowledge is introduced.

**Epistemic doubt.** Epistemic doubt “is viewed as a specific form of cognitive dissonance associated with questioning one’s beliefs about knowledge or knowing” (Rule & Bendixen, 2010, p. 99). What do I believe, and why? This stage of questioning can involve doubting some or all aspects of existing epistemic beliefs. However, epistemic doubt requires epistemic volition to create change in beliefs.

**Epistemic volition.** Epistemic volition is an action process of controlled individual choice where the individual takes “responsibility for their epistemological beliefs” (Rule & Bendixen, 2010, p. 99) and then initiates a change.
**Resolution strategies.** Resolution strategies are actions taken by an individual to sustain or reinforce a change in epistemic beliefs. Rule and Bendixen (2010) identify “reflection, social interaction, and …retrospective review” (p. 100), as some of the resolution strategies.

Collectively epistemic doubt, epistemic volition, and resolution strategies constitute the mechanism of change for disequilibration leading to acceptance of new knowledge and epistemic belief change (Rule & Bendixen, 2010). These three components are interrelated and progressive. However, during the process of equilibration (seeking balance between new knowledge and existing knowledge), individuals can return to their existing knowledge during any of the three stages. Therefore, one could experience epistemic doubt, but during epistemic volition return to doubt or existing beliefs without further progression.

**Reciprocal causation.** Personal epistemology influences one’s environment. However, “the personal epistemologies of others with whom that individual comes into contact” (Rule & Bendixen, 2010, p. 100), also influence an individual’s personal epistemology. Discussion and feedback among others can influence individuals resulting in an epistemic multiplier effect creating larger change (Rule & Bendixen, 2010).

**Dimensions of beliefs.** These pertain to the belief dimensions postulated by Hofer and Pintrich (2002) discussed in the previous section on personal epistemology: simplicity of knowledge, certainty of knowledge, justification for knowing, and source of knowledge.

**Metacognition.** Metacognition is an internal process of consideration where an individual thinks about or explores their own thinking, beliefs, and learning processes (Rule & Bendixen, 2010). This personal exploration can include self-reflection or verbalization of ideas.

**Affect.** Affect involves emotion that can “constrain and/or facilitate epistemological development” (Rule & Bendixen, 2010. p.101). Emotion has been linked to intrinsic motivation
(Deci, Ryan, & Koestner, 1999) that can contribute to decision-making.

**Environment.** An epistemic climate where influence can occur, such as peer interaction and teacher influence in learning environments (Rule & Bendixen, 2010).

**Equilibration.** A process of accommodation “changing existing schemes to fit new information encountered” and assimilation “incorporating new information into existing schemes” (Rule & Bendixen, 2010, p. 101).

Theoretical perspectives on mechanisms of change and change of perceptions is included in components of DI theory (Rogers, 2003). Rogers (2003) hypothesizes that as knowledge about an innovation is considered, social communication and interaction can persuade and influence decisions. However, detail on the cognitive processes of the persuasion and influence stages are not clearly accounted for in DI theory. This creates a gap in understanding how the innovation-decision process works. It is not yet understood if or how the hypothesized IM (Bendixen & Rule, 2004) is accounted for in innovation decision-making and what role epistemic change plays in the education of faculty. In addition, literature reveals the four-stage innovation-decision process of knowledge, persuasion, decision, and implementation has not been evaluated for IM processes. Next, an explanation of each stage of the innovation-decision process is related to IM theory.

**Knowledge stage.** When an individual is introduced, or re-introduced, to an item as an innovation. The characteristics of the item are presented as new or in a new way so that the individual understands how the item functions (Rogers, 2003). Three types of knowledge help to form an individual’s understanding: awareness-knowledge, how-to-knowledge, and principles-knowledge. These types of knowledge represent a continuum of acknowledging the existence of an innovation, understanding how to use the innovation, and lastly an understanding of the
principles that govern why an innovation works (Sahin, 2006). This initial exposure of new knowledge could be associated with current epistemic beliefs and conditions for change in IM theory. This stage primarily involves a traditional one-way transfer of knowledge to an individual without consideration and judging processes. Another consideration during this stage is the role of the learning environment in dissemination of knowledge. This study seeks to align the learning that occurs during group collaboration and knowledge about the attributes of an innovation with the IM components of conditions for change and environment.

**Persuasion stage.** An individual contemplates knowledge received and determines a favorable or unfavorable perception and attitude towards the innovation. However, Rogers (2003) notes, “The formation of a favorable or unfavorable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection” (p. 176). A degree of uncertainty exists that must be satisfied before persuasion is achieved. This degree of uncertainty could be associated with cognitive dissonance and epistemic doubt indicated in the IM. Sahin (2006) also explains, “The persuasion stage relies upon information that is more receptive to the affective domain triggering a judging or valuing prompt” (p. 16). The affective valuing or judging of an innovation could trigger epistemic doubt during the persuasion stage. This study seeks to determine if the IM components of epistemic doubt, epistemic volition, and resolution strategies can be differentiated during the persuasion stage. In addition, reciprocal causation of peer influence during collaborative learning must be considered in persuasion.

**Decision stage.** An individual can engage in activities to develop a working knowledge of an innovation and determine a choice of adoption or rejection. Rogers defines adoption as, “full use of an innovation as the best course of action available,” whereas rejection means, “not to adopt an innovation” (Rogers, 2003, p. 177). Decisions are not static and can change during
any point in the decision process. At the decision stage, attributes of innovativeness may be perceived by an individual stimulating epistemic volition, a choice to consider how the innovation may influence their existing epistemic beliefs (Rule & Bendixen, 2010). In addition, epistemic volition would involve individuals taking responsibility for their choice to adopt the innovation.

**Implementation stage.** In this stage, an individual decides to make use of the innovation and adopts it into practice. Resolution strategies of accommodation or assimilation of the new knowledge could be manifest at the implementation stage. Individuals may choose to implement an innovation as it was presented or individuals may choose to re-invention or modify the innovation in a manner more suitable to their expectations or needs (Rogers, 2003).

**Confirmation stage.** During confirmation, an individual seeks reinforcement of their decision. This stage could correspond with affect and reciprocal causation where emotion and social influences are explored for reinforcement of decisions. However, a lack of reinforcement or conflicting messages about an innovation could change a decision resulting in modification of an innovation or rejection and a return to existing epistemic beliefs (Sahin, 2006, Bendixen & Rule, 2010).

A question exists whether the cognitive processes associated with epistemic belief change can be associated with the innovation-decision process. This query can lead to greater clarity of how individual change contributes to social change, a primary focus of DI theory (Rogers, 2003). The theoretical framework of the IM is explored as one possible explanation for achieving this clarity.

**Faculty epistemic belief change and assessment practice.** The research on epistemic belief change related to faculty assessment methods was very sparse. However, research exists
on the effect of epistemic belief change on teaching beliefs and strategies used in the learning environment. The qualitative study by Marra (2005) suggests belief change in faculty can occur only when faculty adopt non-traditional teaching practices such as constructivist learning environments that challenge traditional teacher-centered practices. Further, epistemic change only occurred when faculty participated with students during constructivist learning. Marra describes constructivist-learning environments as authentic situations and problems where faculty can provide scaffolding and coach learners in problem solving. Sophistication of epistemic beliefs was shown to increase in faculty who exhibited a “zone of readiness” (Marra, 2005). However, further research could not be found correlating faculty zone of readiness and learning that occurs during higher education faculty development about assessment of learning. Additional research is needed to study the social cognitive processes and decision-making associated with faculty learning and assessment practice.

**Research gaps and future directions.** Faculty resistance to assessment of learning may be mostly due to their lack of knowledge about current assessment of learning practice. However, existing research reveals few studies that measure knowledge gained or epistemic belief change during faculty development (Marra, 2005 or investigate the cognitive processes of faculty when considering new knowledge about assessment. Studies conducted by Haviland, Shin, and Turley (2010; 2011) show potential by using a theoretical approach to changing faculty assessment practice. The literature reveals faculty prior experience with assessment and perceptions of assessment may affect new knowledge received about assessment of learning. An analysis of the strengths and weaknesses of DI theory identify that the innovation-decision process needs to be studied further for specific mechanisms of change. The theoretical model for this study will address these gaps in the research by focusing on epistemic belief change that
occurs when faculty are exposed to an assessment innovation introduced during faculty
development. Collaborative learning and perceived innovativeness are additional factors to
explore in epistemic belief change.

Summary

This chapter introduced the relevant scholarly research on assessment issues in higher
education. A brief historical account of the assessment movement was provided as background
and rationale for faculty resistance towards assessment of student learning. Three areas emerged
from the literature to inform the study (a) lack of research connecting faculty epistemic beliefs
with how faculty teach and assess learning; (b) gap in the research connecting cognitive
processes with social change process; and (c) lack of professional development models on
assessment of learning that uses collaboration and innovation to change epistemic beliefs.

The research presents that changing faculty behavior begins with influencing change in
faculty perceptions, but studies could not be found that examine the influence of faculty
epistemic beliefs on faculty assessment of student learning in higher education. To encourage
faculty participation in current authentic assessment activities and increase faculty reporting of
assessment findings, a theoretical model of change must address the cognitive processes of
considering new knowledge, choices that affect the old knowledge, and the actions that result
from decision-making. Thus, the current study considers the theoretical constructs of the IM
(Bendixen & Rule, 2010) to explore faculty epistemic beliefs and decision-making when new
knowledge is presented as an innovative strategy to enhance and benefit their current assessment
methodology. This study strives to answer the research questions “what are faculty epistemic
beliefs about assessment of student learning?”; “how are epistemic processes used to
comprehend and make decisions about a workshop innovation?” and “how do innovativeness
and collaborative learning affect epistemic beliefs during the innovation-decision process?”

Consideration was given to the social influences that affect comprehension in a collaborative learning environment. Thus, both the individual and group changes identified in DI theory (Rogers, 2003) can achieve greater clarity.
CHAPTER 3: METHODS

The previous chapters introduce and describe the research related to assessment in higher education, social change strategies, and belief constructs foundational to teaching, learning, and assessment. The literature revealed that to affect change in faculty perceptions and participation in assessment of student learning institutions must consider strategies that observe faculty as individuals and as a dynamic group of decision-makers (Kezar, 2014). Therefore, the focus of this study is to explore the perceptions and decisions of community college faculty as both individuals and group decision-makers as they consider new knowledge about assessment of learning, practice using an innovative classroom assessment technique, and decide whether to adopt the technique in their teaching practice.

This study utilizes a mixed methods research design to analyze the quantitative data collected from 193 workshop participants as well as qualitative data from a criterion-based research sample of 30 workshop participants who consented to participate in a focus group discussion about their decision-making processes when participating in the workshop series. Decision-making of individuals and groups are a complex phenomenon (Kezar, 2014), so a constructivist view was needed (Lampi, Dimino, & Taylor, 2015) to target how decision-making occurs when faculty consider new knowledge in a learning environment. I anticipated that the conceptualized ideas and lived experiences of the workshop participants would enhance the quantitative findings. The mixing of both methods in this study capitalizes on the strengths to overcome the individual weaknesses of each strand (Plano Clark & Ivankova, 2016). Therefore, I selected a mixed methods design for this study to generate greater meaning from each strand from which to draw inferences about faculty as individual decision-makers and as a social group of decision-makers that may be useful at other institutions of higher education.
There are five sections in this methods chapter. First, an overview of the research design and rationale is provided, as well as an overview of the curriculum and procedures of the workshop series. Second, the study population is described, and parameters for selection of the participants are clarified. Third, data collection instruments from the workshop are introduced, psychometric properties are described, as well as constructs identified to operationalize the variables. Fourth, details regarding the mixed methods data collection are described and illustrated, and procedures used to address human subjects and ethical considerations are clarified. Finally, an explanation of the mixed methods analysis and data integration are associated with visual representations used to formulate the inferences in this study.

**Research Design**

This convergent parallel mixed methods study (Creswell & Plano Clark, 2011) uses concurrent quantitative (i.e., workshop data from pre/posttest and surveys) and qualitative strands of inquiry (i.e., focus group) to study faculty epistemic beliefs and the innovation-decision processes. Equal priority is given to data collection and analysis of each method strand with the converging of strand results into integrated data patterns for analysis, interpretation, and final inferences (Creswell & Plano Clark, 2011). Morgan (2014) claims that greater legitimacy and certainty of findings result from using the strengths of converged data to answer each research question of a study. A convergent mixed methods design and pragmatist perspective are complimentary to achieve an objective or explore practical and policy implications (Morgan, 2014; Trochim & Donnelly, 2008). The research team hoped to learn what influence the strategies of the professional development workshop series had on faculty epistemic beliefs and how faculty innovation decision-making affected faculty decisions to adopt CATs into their teaching practice. Inferences of this study may be used to make decisions about future
professional development offerings, institutional policies, and assessment procedures. In addition, using a mixed methods design can provide detail about decision-making and have greater legitimacy for inference transferability to a broader range of academic populations (Teddlie & Tashakkori, 2009).

**Theoretical Framework**

The theoretical framework selected facilitates inquiry into how innovation and collaborative learning may affect epistemic development as faculty learn new knowledge about a classroom assessment technique. The IM-IDM illustrates that faculty (1) consider knowledge introduced about an innovation presented during professional development, (2) compare the new knowledge beliefs about assessment of student learning with existing knowledge beliefs to experience epistemic doubt, (3) exercise epistemic volition, and (4) determine courses of accommodation or assimilation (resolution strategies) when making decisions about an innovation (see Figure 2). In addition, a comparison of collaborative learning constructs and constructs of reciprocal causation may reveal a social effect on sophistication of epistemic beliefs. The IM-IDM accommodates using a mixed methods typology where the merging of qualitative data and quantitative data provides greater insight. The research design of this study (a) allows for a comparison of epistemic change processes; (b) outlines quantitative and qualitative collection and analysis processes of study participant data; (c) and how data independent stands will be converged, integrated, and reduced to inferences.

This two-phase study includes analysis of assessment data collected during a professional development workshop series offered in two different semesters, and a focused examination of a criterion-based sample of participants from each workshop series who consented to participate in a focus group study. An analysis of the workshop data (quantitative) and focus group
data (qualitative) first involved analyzing each data strand independently with their respective analytic processes. Next, an integrated analysis was performed to merge data from each independent analyses into a new coding system. Visual displays helped to map patterns from findings. Patterns were analyzed to answer each research question and determine achievement of expectations. Finally, inferences were determined to address the pragmatic purpose of this study.

**Research Questions**

Q1. How do faculty epistemic beliefs about assessment of learning change when attending a professional development workshop series on classroom assessment techniques?

Q2. Which cognitive processes are apparent when faculty are making innovative-decisions?

Q3. What effect do innovativeness and collaborative learning have on epistemic beliefs about assessment of learning when faculty experience the innovation-decision process?

**Research Expectations**

For this study, was expected that most faculty would:

1. Demonstrate an increase in sophisticated epistemic beliefs about assessment of learning because of the innovative professional development workshop strategy.

2. Differentiate and express cognitive processes occurring during innovation decision-making.

Each of the research expectations will lead the discussion in chapter five.

**Overview of Workshop Series**

Discussed in this overview is a chronology of the faculty professional development workshop series used as a social change strategy to create a culture of assessment at the research site. I begin with the justification for development, pilot study findings, curriculum design, and implementation components. In spring 2017, a three-part professional development workshop
series conducted at a large southwest urban community college provided education to faculty on a method of authentic classroom assessment that was not evident at the institution. Although widely used in higher education, institution leaders hoped faculty at the institution would perceive the attributes of this new method as innovative and attractive. The workshop curriculum introduces faculty to components of Angelo and Cross’ (1993) Classroom Assessment Techniques (CATs). CATs designed for these series were an authentic direct assessment measure aligned with student learning outcomes to measure student ability. Generally, faculty at the institution predominantly report course final grades as indicators of students demonstrated achievement of student learning outcomes. All full- and part-time faculty have the opportunity to enroll in the professional development series each semester, but the enrollment capacity of each workshop series is limited to 120 participants. As part of the current study, permission was obtained from the institution to analyze the datasets collected during the spring and fall 2017 offerings of the workshop series. An overview of the workshop series design and curriculum components follow to clarify the type of quantitative data analyzed in the current study. The goal of the institution is to have (a) 80% of the workshop participants complete the workshop series, and (b) 80% of workshop completers adopt CATs into their course curriculum. Institution administrators anticipate with achievement of these two goals faculty will increase use of authentic measures to report achievement of student learning outcomes.

**Workshop series pilot study.** The purpose of the workshop pilot study conducted at the institution with a sample of 49 full and part-time faculty (Peterson, 2016a; 2016b) was to evaluate the curriculum content, data collection measures, and determine a sustainable cohort size for a multi-part series. Results of the pilot study analysis led to modifications in two data collection instruments and reduction of the series from four 3-hour sessions to three 2-hour
sessions. Pilot study feedback indicated faculty reasoning for not persisting in more than two sessions was (a) concern over the amount of time they needed to commit to the workshops and (b) lack of justification for spending time away from their teaching responsibilities. Feedback also revealed most faculty groups in the workshops collaborated more frequently on tasks outside of the workshop sessions than within the sessions. Faculty suggested using the learning management platform to facilitate more collaborative learning outside of the workshop sessions. The workshop designer incorporated all suggestions and presented a scale up plan to administration as a perpetual intervention strategy to establish a culture of assessment at the institution. Administration approved implementation for spring 2017 and requested program monitoring, data analysis, and annual reporting.

**Workshop design.** The workshop design embeds constructs of innovativeness and diffusion from DI theory (Rogers, 2003) and follows curricular components of the 4-part series model of Haviland, Shin, and Turley (2010). The workshop design includes two teaching strategies in the delivery of the CATs curriculum: presenting a concept as having innovative attributes, and facilitating diffusion of a learning concept through collaborative learning in groups. A brief overview of the workshop curriculum sequence with both in classroom and online sessions is presented to explain how the innovation of CATS was introduced to the participants, the collaborative learning strategy was utilized, which activities participants were asked to complete, and the corresponding assessment measures deployed by the institution professional development staff (see Figure 5).

**Workshop curriculum.** Workshop facilitators, who are administrative faculty at the institution, provide participants with knowledge about the purpose, value, and utilization of CATs, and then participants apply the new knowledge to given tasks in collaborative learning
groups of five to seven self-selected members. Within the workshops, the group members collaborate to evaluate the new knowledge presented to them about CATs and complete two group assignments that provide them with hands on experience with the purpose and usefulness of CATs. After the workshop sessions, participants complete individual assignments and participate in evaluative peer review experiences, increasing their collaborative learning time together. The core curriculum focuses on associating the purpose and usefulness of CATs with its’ attributes of innovativeness. A description of the CAT curriculum presentation follows.

Figure 5. Workshop Design and Curriculum Sequence

<table>
<thead>
<tr>
<th>Classroom Session Activities</th>
<th>Workshop 1</th>
<th>Workshop 2</th>
<th>Workshop 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation:</td>
<td>Overview of assessment process</td>
<td>Using CATs as signature assessments of outcomes</td>
<td>Use and reporting of CAT evidence</td>
</tr>
<tr>
<td>Introduction to Classroom Assessment Technique (CAT)</td>
<td>Faculty role in course assessment</td>
<td>Faculty role in institutional improvement</td>
<td></td>
</tr>
<tr>
<td>Cohort collaborative learning:</td>
<td>Group CAT practice-designing and implementing a CAT</td>
<td>Group CAT use-curriculum mapping and measurement of course outcomes</td>
<td>Group CAT use-“Assessment Review” simulation of implemented CATs</td>
</tr>
<tr>
<td>Individual assignment:</td>
<td>Post of course CAT</td>
<td>Post of course curriculum map</td>
<td>Post of peer review rater simulation</td>
</tr>
<tr>
<td>Cohort Collaborative Learning:</td>
<td>Peer feedback on individual CAT assignments</td>
<td>Peer feedback on individual course curriculum maps</td>
<td>Inter-rater analysis discussions</td>
</tr>
<tr>
<td>Canvas Post Session Activities</td>
<td>Discussion of attributes of CAT innovativeness and faculty concerns about assessment</td>
<td>Discussion of CAT use and faculty concerns about course-level assessment</td>
<td>Discussion of CAT implementation and faculty concerns about institution-level assessment</td>
</tr>
</tbody>
</table>

**Classroom Assessment Techniques (CATs).** CATs are associated as an innovative way to collect and measure student ability through direct observations within classroom time.

Multiple CATs, extracted from the Angelo and Cross (2003) text, were taught in collaborative
learning sessions and concepts practiced during each workshop session. CATs address faculty concerns about assessment of student learning as arduous and time consuming. CATs are ready-made assessment activities and measurement instruments designed to target specific learning domains (i.e., cognitive, affective, or psychomotor) and/or critical thinking abilities (see Appendix A). Workshop participants are given the opportunity to customize a CAT for a course they currently teach, receive feedback from peers on how the CAT could be improved, and then encouraged to adopt the CAT in a current course they are teaching. A description of the collaborative learning environment and strategies used in the workshop series follows.

**Collaborative learning.** The diffusion strategy chosen to facilitate increased knowledge and acceptance of CATs was collaborative learning among peers. Participants self-selected their group members from those known in the workshop or those within close proximity to their chosen seating arrangement. During the workshop learning sessions, collaborative groups participated in discussions to (a) judge the innovativeness of CATs; (b) share contrasts and comparisons of how to use the CAT strategy; and (c) analyze the utility of the CAT components based on their decisions about the new knowledge. After a workshop session, each individual within a group designed a CAT for a course they were currently teaching and uploaded it into the institution online learning management platform for discussion and peer feedback as a collaborative group project. Each group member conducted a peer review evaluation for two other group member CAT submissions. Peer review involved using a rubric to evaluate submissions and provide narrative feedback. Peers evaluated to what degree (a) did the selected CAT facilitate demonstration of the expected learning outcome behavior skill; (b) was there clarity in the reasons and justification for the selection, purpose, and use of the CAT; and (c) were the designed steps and components feasible and realistic for the students to complete and
implement in the classroom? In addition to the collaborative learning and peer review feedback, participants completed assessment measures to provide information about their epistemic beliefs and perceptions of the workshop teaching strategies.

**Workshop data collection.** Four assessment measures were administered in the workshop series (a) pre-posttest measures participant epistemic beliefs about assessment of student learning in the classroom; (b) survey on perceptions of the workshop collaborative learning strategy; (c) survey on the innovativeness of CATs as a new assessment strategy; and (d) participants’ type of decision to adopt CATs in their classrooms. The pre-test was administered at the beginning of workshop one and post-test was administered at the end of workshop three along with surveys on collaborative learning and innovativeness. Four weeks after completion of the workshop series, participants logged into the learning management system to complete the institution generated professional development course evaluation that includes one question asking participants to indicate the type of decision they determined about adopting CATs into their teaching practice.

**Participants**

The population for the current study is full and part-time faculty at a large multi-campus southwest community college. The college is a Hispanic Serving Institution (HSI) and serves over 70,000 students from three main campuses. The faculty population at the institution consists of 533 full-time tenured and non-tenured faculty, and 1343 part-time faculty teaching within six academic schools (three liberal arts and three applied). Part-time faculty teach up to nine (9) instructional units per semester with the average part-time faculty member teaching seven (7) instructional units per semester.
Demographic Profile of Workshop Population

The study population that participated in the professional development workshop series consisted of 193 full and part-time faculty with 103 faculty participating in the spring and 90 participating in the fall. The institution anticipated enrollment of 120 participants for each workshop series. However, the actual enrollment capacity was 86% for the spring series and 75% for the fall series. There was greater participation in the spring workshop series (N = 103) than the fall series (N = 90) despite equal marketing of each workshop series by the institution four weeks prior to the first workshop. The institution allocated the four weeks prior to the workshop for announcing and marketing the series. These four weeks of August and December were both off-contract months for faculty. Since faculty were not on campus this may have contributed to the less than capacity registration for each series.

For the combined spring and fall series, there were 156 full-time and 36 part-time faculty participants (see Table 2). There were 82 (80%) full-time and 21 (20%) part-time faculty in the spring series and a similar distribution in the fall series of 74 (82%) full-time and 16 (18%) part-time faculty. Although the majority of workshop participants were full-time faculty, the distribution of full to part-time faculty was relatively equal for each series.

<table>
<thead>
<tr>
<th>Faculty Status</th>
<th>Enrolled in Workshop Series</th>
<th>Series completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>156 (80.8%)</td>
<td>84 (54%)</td>
</tr>
<tr>
<td>Part-time</td>
<td>37 (19.2%)</td>
<td>17 (46%)</td>
</tr>
<tr>
<td>Total</td>
<td>193 (100%)</td>
<td>101 (52.3%)</td>
</tr>
</tbody>
</table>

Each workshop series was offered as four separate cohorts each on a different day and time. Participants registered for the cohort that best accommodated their schedule. Participants met with their cohorts on their designated day and time once a month for three consecutive months during the semester. Within each cohort, participants divided into self-selected groups of
five to seven faculty to participate in the workshop active learning strategy of collaborative
learning and additional collaborative learning activities within the online learning platform (see Table 3).

Table 3. Workshop Participation by Series Cohort and Collaborative Learning Group

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A GROUP</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>B GROUP</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>C GROUP</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>D GROUP</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

To receive a certificate of workshop completion, participants had to participate in all three workshops and complete the three associated workshop activities. The combined completion rate for the spring and fall workshop series was more than half the participants, but did not achieve the institution goal of 80% (see Table 4). However, 82% of spring and fall workshop participants (n = 129) indicated that by workshop three they had implemented some of the CAT activities they learned from the workshops into their current courses, but had not collected any data. At the thirty-day post-workshop evaluation administered by the institution,
99% of the workshop completers (n = 100) reported they had adopted the CAT they designed in the workshop series in their current course. The institution considers the workshop series to be an effective program for motivating faculty to consider new methods of assessment and continues to offer the CAT workshop series each semester, but has not yet compared student learning outcome measures with workshop participation and completion. From the population of 193 workshop participants, a research sample was selected to explore the innovation decision-making processes faculty used when considering adoption of the innovativeness of CATs. Next is a discussion of how I determined the sample size for the study.

Table 4. Workshop Participation and Completion

<table>
<thead>
<tr>
<th>Workshop Participation</th>
<th>Workshop 1</th>
<th>Workshop 2</th>
<th>Workshop 3</th>
<th>Series Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Series</td>
<td>103</td>
<td>92 (89%)</td>
<td>89 (86%)</td>
<td>51 (49.5%)</td>
</tr>
<tr>
<td>Fall Series</td>
<td>90</td>
<td>86 (96%)</td>
<td>74 (82%)</td>
<td>50 (55.6%)</td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
<td>178 (92%)</td>
<td>163 (84%)</td>
<td>101 (52.3%)</td>
</tr>
</tbody>
</table>

**Determination of sample size.** Three considerations were used to determine an appropriate sample size for the focus groups and determine whether the data sets from the workshop had enough power to conduct the appropriate quantitative statistical analyses needed in this study: (a) review of sample sizes from previous studies, (b) power analysis application, and (c) mixed method researcher expertise.

**Previous studies.** Haviland, Shin, and Turley (2010) used a four-part workshop series based on a DI framework and measured faculty perceptions of and confidence in, using assessment in a mixed methods study with 44 faculty. The researchers reported that the sample size did not have enough power to produce a statistically significant effect in pre and post-test comparisons ($p = .451$) or MANOVA repeated measures for confidence in ability ($p = .562$). In contrast, Yost, Ciliska, and Dobbins (2014) conducted an explanatory mixed methods study to measure the effects of a five-day intensive workshop on evidence-informed decision-making.
with a small convenience sample of 51 faculty. Pre and posttest results showed a statistically significant increase in knowledge and skills in the first six months \( (p < .001) \) and a statistically significant decrease in retained knowledge and skills at a six-month follow-up \( (p = .018) \).

The majority of mixed methods studies reviewed were qualitative with sample sizes less than 30 and used opinion surveys rather than test measures to determine change in knowledge. Since the research on measuring increased knowledge of assessment of learning or knowledge change through professional development was inconsistent or non-comparable across studies, the workshop pilot study conducted at the institution was the most similar in research design. However, the effect size with the sample in the pilot study was small. Therefore, a power analysis was conducted to estimate a sample size for this study.

**Power analysis.** A power analysis was conducted with Power and Precision Analysis V2 application (Borenstein, Rothstrin, & Cohen, 2001). The analysis was conducted using the parameters of a paired sample t-test to test a null hypothesis with a significance criterion set at 0.050 and a goal to achieve power above 80%. Results of the power analysis indicated that a study with a proposed sample size of 40 pairs of cases would have power of 86.9% to yield a statistically significant result.

Since this current study design includes an exploration of variable effects, using structural equation modeling, Monte Carlo data simulation techniques were used to evaluate sample size requirements for common applied SEMs. The Monte Carlo model considers the number of factors and attributes assigned to each factor in a structural model design (Muthén & Muthén, 2002). The structural model for this study considers four factors, epistemic beliefs, innovativeness, collaborative learning, and decision about CATs. The ALEBQ collects data on the factor epistemic beliefs about assessment of student learning in four domains or attributes.
The CLQ collects data on the factor collaborative learning with two attributes (individual and group development). The AIS collects data on the factor of innovativeness with five attributes (relative advantage, compatibility, complexity, trialability, and observability). Type of Decision scale measures one factor. The Monte Carlo model was used to estimate a sample size considering a four-factor model with at least three attributes for each factor. The model suggests between 120 – 150 participants to achieve power above .80 (Muthén & Muthén, 2002) needed for the use of a structure equation model in this study.

**Mixed methods researcher expertise.** Onwuegbuzie and Collins (2007) recommend a minimum of 82 participants for a two-tailed hypothesis correlation study of variables. In addition, the researchers recommend a minimum of 12 participants for interviews, and focus group participants should range from six to twelve participants. Each of the minimum number of participants is recommended to detect a statistically significant medium relationship or difference with .80 power at the .05 level of significance (Onwuegbuzie and Collins, 2007).

**Selection of Study Participants**

This study utilized existing data from the larger study population of 193 faculty who participated in an institution-designed series of faculty development workshops on classroom assessment techniques. The institution collected data during the workshop using three assessment measures of program evaluation as institutional effectiveness indicators. The data from the three assessment measures was of particular interest for the current study to establish a baseline of understanding faculty epistemic beliefs on assessment of learning. The database of workshop participants and their assessment data was obtained from the institution through permission of the professional development center administrator (see Appendix B). From this
larger study population a research sample of 30 faculty was determined to explore the phenomenon of innovation decision-making processes.

Recruitment. Recruitment and management of participant consent was conducted according to approved IRB protocols. A recruitment invitation to participate in a research focus group was sent to all 193 participants of the workshops through the internal institution email system. The recruitment letter requested that participants read about the parameters of the current study, the risks, and benefits of participating in the study; and respond within 14 days if they consented to participate in a focus group (see Appendix C). Participants returned their signed informed consent forms electronically through the institutions’ secure intranet email system or in hard copy through sealed inter-institutional mail system.

Confidentiality. Both the recruitment letter and informed consent documents explained how private information of participants would be used, and protected. The informed consent document specified: (a) how participant data would be managed during and after collection; (b) the time commitment, confidentiality measures, and data collection procedures; (c) how the research team would be the only individuals to have access to their personal information; and (d) how personal information about research participants would not be shared with their employers.

The informed consent form let participants know that confidentiality could not be assured if they agreed to participate in a focus group. However, fictitious pseudonyms were assigned to the information they provided. Protocols also clarified that all hard and electronic participant data would be stored in a locked file cabinet at the institution. All electronic data used in this study is maintained in a password-protected file on the researcher's assigned institution laptop computer and will remain there or five (5) years. Thereafter, the electronic items would be permanently removed from the computer and all hard copy items would be shredded.
The confidentiality protocols also clarified that it was unlikely that participants who consented to the study would experience any benefit or harm differently from those who did not consent, or that discussions and interactions of the consenting participants would be different from ordinary discussions or interactions encountered at their work. Both the recruitment letter and informed consent documents indicated that the researcher intends to publish this dissertation and the results of this study may be used for pragmatic decisions at the institution regarding professional development offerings and assessment protocols.

**Criterion-based selection of sample.** Those individuals providing consent to participate in a focus group were cross-referenced with the workshop database information and using a criterion-based selection system were placed into categorical research groups according to workshop series of participation (spring series or fall series) and whether participants completed or did not complete all requirements of the workshop series. The goal was to achieve a minimum of seven individuals in each of four focus groups (i.e., focus group 1- spring workshop series completers, focus group 2- spring workshop series non-completers, focus group 3- fall workshop series completers, and focus group 4- fall workshop series non-completers).

As individuals provided consent, I notified them of their acceptance providing the day and time of the focus group session. Thirty-eight individuals provided consent to participate in this focus group study (10 spring completers, 9 spring non-completers, 8 fall completers, and 11 fall non-completers). Not all who provided consent could attend the day and/or time of the focus groups and therefore eight individuals could not participate. After three rounds of solicitation to participate, the research sample groups were determined as focus group A spring series completers (n= 8), focus group B spring series non-completers (n = 8), focus group C fall series completers (n = 7), and focus group D fall series non-completers (n=7). The sample comprises
19 percent of the workshop population. A profile of the 30 research focus group participants according to group assignment, faculty status (full-time or part-time), and the fictitious research identifier they were assigned is provided in Table 5.

Table 5. Focus Group Participants by Workshop Series, Completion and Employment Status

<table>
<thead>
<tr>
<th>Focus Group 1</th>
<th>Focus Group 2</th>
<th>Focus Group 3</th>
<th>Focus Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring Completer</strong></td>
<td><strong>Spring Non-completer</strong></td>
<td><strong>Fall Completer</strong></td>
<td><strong>Fall Non-completer</strong></td>
</tr>
<tr>
<td>Name</td>
<td>Status</td>
<td>Name</td>
<td>Status</td>
</tr>
<tr>
<td>Ann</td>
<td>F</td>
<td>Amy</td>
<td>P</td>
</tr>
<tr>
<td>Barbara</td>
<td>F</td>
<td>Beth</td>
<td>F</td>
</tr>
<tr>
<td>Carl</td>
<td>F</td>
<td>Charles</td>
<td>F</td>
</tr>
<tr>
<td>Donna</td>
<td>F</td>
<td>Denise</td>
<td>F</td>
</tr>
<tr>
<td>Evan</td>
<td>F</td>
<td>Ellen</td>
<td>P</td>
</tr>
<tr>
<td>Frank</td>
<td>F</td>
<td>Felicia</td>
<td>F</td>
</tr>
<tr>
<td>Gwen</td>
<td>F</td>
<td>Greg</td>
<td>F</td>
</tr>
<tr>
<td>Harold</td>
<td>P</td>
<td>Henry</td>
<td>F</td>
</tr>
</tbody>
</table>

n = 8  
n = 8  
n = 7  
n = 7

Notes. F = full-time faculty. P = part-time faculty. n = number of participants in focus group.

Instruments

**Dependent and Independent Variables**

Two independent variables (i.e., collaborative learning and innovativeness) were hypothesized in this study to influence two dependent outcome variables (i.e., faculty epistemic beliefs and adoption decision). As part of workshop development, administrators at the research institution solicited a panel of reviewers to modify three quantitative measures for workshop data collection (Peterson, 2016a; 2016b). One reviewer is a director of institutional effectiveness at a private northwest university with over 15 years of institutional assessment experience and two faculty are members of the institution assessment committee with 30 combined years of teaching and assessment experience.

Quantitative measures administered in the workshops that were used to operationalize the variables consisted of (a) pre- and post-workshop test (to determine a change in sophistication of faculty epistemic beliefs about assessment of student learning), (b) survey of faculty perception
of the workshop teaching strategy (collaborative learning), (c) survey of faculty perception of CATs (attributes of innovativeness), and (d) workshop outcome indicator (faculty decision to adopt the innovation CATs). A pilot study analysis conducted by the institution to test quantitative measures for internal consistency yielded acceptable Cronbach Alpha values above .7 (Peterson, 2016a; 2016b). However, a thorough content validity analysis was not conducted because the sample was small and not random. Qualitative measures constructed to obtain data from the research sample include questions for focus group discussions to examine how cognitive processes hypothesized in the IM-IDM occur during innovation decision-making in faculty. A pilot of the focus group questions was conducted with ten volunteers who participated in the original workshop pilot study. Participant feedback was used to revise and refine the measurement tool. A discussion of each quantitative and qualitative instrument design, validity analysis, and use for data collection found in the literature is compared with the data collection findings and validity analysis from the pilot studies (Peterson, 2016a; 2016b).

**Data Collection**

**Assessment of learning epistemic beliefs questionnaire.** The Assessment of Learning Epistemic Beliefs Questionnaire (ALEBQ) is a standard measure of the workshop to collect data on faculty epistemic beliefs about assessment of learning (See Appendix E). The ALEBQ is a topic-specific modification of the Epistemic Beliefs Questionnaire (TSEBQ) developed by Braten, Gil, Stromso, and Vidal-Abarca, (2009). The TSEBQ is highly adaptable and has yielded high validity in a variety of topics including internet use (Kammerer, Braten, Gerjets, & Stromso, 2013; Stromso & Braten, 2010), climate change (Braten, Gil, Stromso, & Vidal-Abarca, 2009; Braten, Stromso & Samuelstuen, 2008), and potential health risks (Ferguson & Braten, 2012).
The 24-item instrument uses a 10-point Likert type scale ranging from (1) strongly disagree to (10) strongly agree and measures two constructs: the degree of naïve or sophistication of epistemic beliefs in each of four domains (i.e., certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowing) adapted from Hofer and Pintrich (2002). Scores of low value represent naïve epistemic beliefs and high values represent beliefs that are more sophisticated. Measures of internal consistency for the TSEBQ yielded high Cronbach Alpha values for each dimension range from .68 -.70 for certainty of knowledge, .60 -.68 simplicity of knowledge, .68 -.71 source of knowledge, and justification for knowing .68 -.71, (Stromso, Braten, & Britt, 2011). The TSEBQ has also been subjected to factor analysis and has been shown to have high levels of content validity and construct validity $X^2 (43, n = 135) = 64.67$, $p = .018$, goodness-of-fit index = .93, adjusted goodness-of-fit index = .89, comparative fit index = .90, root-mean-square error of approximation (RMSEA) = .051. In addition, the confidence limits for RMSEA were 0.00 and 0.08 (Stromso, Braten, & Samuelstuen, 2008, p. 826).

Measures of internal consistency reported for the ALEBQ in the workshop pilot study are similar to those reported for prior studies found in the literature (Stromso, Braten, & Samuelstuen, 2008): certainty of knowledge $\alpha = .62$, simplicity of knowledge $\alpha = .68$, source of knowledge $\alpha = .74$, and justification for knowing $\alpha = .68$. Content validity analysis of the ALEBQ will be included in this study.

**Collaborative learning questionnaire.** The Collaborative Learning Questionnaire (CLQ) is derived from an 8-item independent collaborative learning scale developed by So and Brush (2008) as part of the Collaborative Learning, Social presence, and Satisfaction questionnaire (CLSS). Use of the CLSS has been used primarily in the study of online learning
environments specifically with collaborative learning components (So & Brush, 2008; Sorden & Munene, 2013; Zhu, 2012). Content validity was established through a panel of experts, pilot study, and factor analysis. Forty-eight graduate students in a blended-format health education course completed a 56-item instrument to measure students’ perceived levels of collaborative learning, social presence, and overall satisfaction (So & Brush, 2008). During exploratory factor analysis using principal component analysis extraction method for factor reduction, the Kaiser-Meyer-Olkin measure of sampling was adequate and Bartlett’s tests of sphericity were satisfied (So & Brush, 2008). Through factor analysis reduction, the original collaborative learning scale of 12 items reduced to eight items and manifested an independent Cronbach’s alpha value of .72. As an additional comparison, the CLSS was used in a cross-culture correlation analysis of Caucasian and Latino populations with statistically significant high, positive correlations ($r = .750, p = .01$) between collaboration and satisfaction scales, with statistically significant moderate positive correlations ($r = .586, p = .01$) between collaboration and social presence.

The panel of reviewers for the workshop pilot study (Peterson, 2016a; 2016b) were tasked to modify the CLSS collaborative learning scale by deletion of two items, creation of two new items, increase in scale measurement, and provided a new name for differentiation from the original scale. The CLQ uses a 10-point Likert type scale ranging from (1) strongly disagrees to (10) strongly agree. Items 1 and 8 of the CLSS collaborative learning scale were eliminated because they were not relevant to the variables operationalized in the current study. The test items were sequentially re-numbered so that original item number two was now item 1, and so forth. Item 7 was modified to read “Collaborative learning with my cohorts helped me to view assessment of learning in a different way.” Item 8 was added to the scale to determine the influence of an innovation during collaborative learning, and reads, “Collaborative learning with
my cohorts influenced my opinion about the innovativeness of classroom assessment techniques” (see Appendix F). Lastly, the eight items were categorized to measure two constructs: individual and group development during collaborative learning sessions.

Pilot test analysis of the CLQ (Peterson, 2016b) revealed good internal consistency with reported Cronbach alpha coefficient values of .86 for total CLQ scores, and subscale constructs of individual development ($\alpha = .86$) and group effectiveness ($\alpha = .83$), which is comparable to the reliability of the original collaborative learning scale (So & Brush, 2008). Pilot testing feedback from participants and reviewers indicated no further modifications to the instrument.

**Attributes of innovations survey.** The Attributes of Innovations Survey (AIS) derives from the five attributes of innovativeness discussed in DI (Rogers, 2003). The review panel for this study created the 12-item measure that uses a 10-point Likert type scale ranging from (1) strongly disagree to (10) strongly agree (see Appendix G). Respondents rate CATs as an innovation with the following attributes: relative advantage, compatibility, complexity, trialability, and observability. Pilot test analysis of the AIS (Peterson, 2016b) indicated good internal consistency ($\alpha = .87$) for total scores, as well as subscale constructs of relative advantage ($\alpha = .81$), compatibility ($\alpha = .78$), complexity ($\alpha = .63$), trialability ($\alpha = .68$), and observability ($\alpha = .88$). These measures of reliability are consistent with the literature. Additionally, pilot testing feedback from participants and reviewers indicated a clarifying statement of “to assess and report achievement of student learning outcomes” be added to the end of question one.

**Type of decision.** A type of decision item used in the pilot study was derived from five choice option described in Rogers (2003) DI theory (i.e., adoption, adoption/re-invented, later adoption, discontinuance, and rejection). For the current study, type of decision was identified as the workshop outcome variable and was the final question of the Attributes of Innovativeness
Survey. The one-item question asks for the decision faculty made on whether to adopt CATs into their teaching practice after completing the workshop series. Type of decision is a level of commitment to adoption. Each decision was assigned a rank on a 5-point ordinal scale in a descending hierarchy of commitment to adoption (see Appendix H).

**Focus group discussion questions.** The purpose of focus group discussions for this study is to explore and differentiate the cognitive processes of faculty during innovation decision-making as hypothesized in the IM-IDM. Three professors at the community college research site who have a Ph.D. in experimental or clinical psychology and members of the research team for this study developed ten open-ended exploratory discussion questions. The three psychology professors have each taught or researched concepts of personal epistemology within the last five years. The professors were provided with definitions for components of the IM-IDM (i.e., epistemic doubt, epistemic volition, resolution strategies, affect, reciprocal causation, metacognition, and equilibration) derived from the literature reviewed in this study. Each professor independently designed an open-ended question that would require faculty to think about the stage of their decision-making and narrate the mental processes of their thinking, choices, and reasoning. This process yielded three sets of ten unique questions. Next, the professors were asked to review each set of questions created for a construct and independently rank the three questions (1-highest and 3-lowest) for each of four factors: essence of the definition, comprehensiveness of the definition, sentence clarity, and neutrality in question design. After round one, consensus resulted in adoption of seven out of ten construct questions. Round two of review involved elimination of the lowest ranked question in each of the three remaining question sets. Next, a member of the research team reviewed and ranked the two questions in each of the three remaining sets using the same four factors, and presented final
question recommendations for adoption by the research team. The focus group discussion questions were pilot tested with ten volunteers who participated in the original workshop pilot study. Feedback from the focus group pilot study participants indicated that definitions needed to be provided for some terms that the participants did not know or where there was inconsistency among the participants in understanding of the terms. Thus, definitions were provided for the terms CATs, accommodation, and assimilation. Sample items included, “How did the knowledge about CATs cause you to reconsider or question your old knowledge about classroom assessment?” and “Describe the changes you made to your old classroom assessment methods through accommodation (replacing your existing classroom assessment methods with a CAT) or assimilation (modifying a CAT to fit your existing classroom assessment methods?)”, (see Appendix I).

**Validity, Reliability, Trustworthiness, and Legitimation**

Threats to external validity of the study were controlled for in multiple ways. A power analysis was conducted to identify a sample size large enough to obtain a significant effect for each of the quantitative measures. However, limitations are stated to acknowledge that not all workshop participants may consent to the use of their data to achieve the minimum sample population. In addition, limitations clarify that inferences may not be generalizable because the sample population used to acquire quantitative data is a convenience sample with characteristics specific to the institution. However, the quantitative data collection instruments used in this study exhibited high psychometric properties of validity and reliability or were planned for content validity through pilot study. Results from factor analysis studies were reported for quantitative measures if available.
Trustworthiness of qualitative procedures and findings were addressed by inclusion of a pilot study of focus group questions, standardization and calibration of a research team for coding and qualitative analysis procedures, and random selection of workshop participants for qualitative data collection. Three faculty administrators were used for coding and thematic analysis and inter-coder reliability was established by using a protocol of consistency checking. Continuous evaluation of all components of the mixed methods design and procedures for this study maintained alignment with the research purpose of the study.

The Integrative Framework for Inference Quality (Teddlie & Tashakkori, 2009) was used as a guide to minimize threats to credibility during interpretation, and to increase inference quality. The framework addresses four domains of design quality (i.e., design suitability, design fidelity, within-design consistency, and analytic adequacy) and are addressed in chapter four, and the six domains of interpretive rigor (i.e., interpretive consistency, theoretical consistency, interpretive agreement, interpretive distinctiveness, integrative efficacy, interpretive correspondence) are addressed in chapter five.

Procedures

The procedures of this study were carried out in two phases of data collection and five stages of data analysis. Phase I involved procedures to acquire a database of workshop assessment measures and conduct quantitative analyses with the data to explain the relationships and effects of the workshop variables (i.e., faculty epistemic beliefs, perceptions of collaborative learning, and perceptions of the innovativeness of CATs). Phase II involved recruitment of a criterion-based sample of 30 workshop participants placed in one of four focus groups: (a) spring workshop series completers (n = 8); (b) spring workshop series non-completers (n = 8); (c) fall workshop series completers (n = 7; and (d) fall workshop series non-completers (n = 7); In this
study, focus groups were selected as the broadest method to understand a range of cognitive processes and gain the greatest insight into faculty decision-making. Grouping workshop participant data by time and decision will generate pragmatic insight for the local population in decisions and procedures for the institution, but result may provide useful for futures research on sustainability of faculty decision-making. Next, the roles of the research team will be discussed as well as procedures for conducting the focus groups.

**Focus Group Procedures**

A one-hour discussion session was conducted with each focus group. One researcher functioned as the focus group moderator and one researcher functioned as note-taker, recorder, and timekeeper. Researcher roles and responsibilities for conducting the focus groups followed guidelines from Kruegar and Casey (2009). The role of moderator included providing definition of terms, facilitating discussion of question responses, determining clarity from responders, and verbally confirming and summarizing responses for the note-taker. Digital recording was used to aid in transcription. Note-taking involving summarizing response key words on large easel pads for respondent clarification and confirmation of intent. Focus group participants were seated in a half-moon arrangement facing the moderator and note taker. The moderator clarified the research team roles, clarified that the nature of the focus groups could not guarantee confidentiality, and described the sequence of the focus group procedures. Last, the moderator provided a reminder that participation was voluntary and focus group members were free to withdraw at any time without penalty. A definition of CATs was provided as a reminder of the focus group topic prior to delivery of question number one.
Mixed Methods Data Analysis

The mixed methods analysis for this study involved five stages using a combined technology approach recommended by Guettermann, Creswell, and Kuckartz (2015) with SPSS AMOS (Version 25) software for quantitative analysis and MAXQDA Analytic Pro (Version 2018) software for mixed methods analysis. Figure 6 visually depicts the five stages of data convergence and analysis used in this study. A description and justification for selection are provided for each of the various mixed analysis processes. Finally, the findings of each mixed methods analyses were mapped and patterns were interpreted to answer each of the three research questions of this study.

Figure 6. Visual Model of Mixed Methods Convergent Data Analysis and Integration Design

<table>
<thead>
<tr>
<th>Convergent Data Analysis &amp; Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 Independent Strand Analysis</td>
</tr>
<tr>
<td>Quantitative</td>
</tr>
<tr>
<td>Survey Data- Descriptive Analysis</td>
</tr>
<tr>
<td>Confirmatory Factor Analysis</td>
</tr>
<tr>
<td>Pre/Posttest- Paired Samples t-test</td>
</tr>
<tr>
<td>Structural Equation Models</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Stage 3 Integrated Analysis and Coding</td>
</tr>
<tr>
<td>Stage 4 Pattern Analysis</td>
</tr>
<tr>
<td>Stage 5 Interpretation and Inferences</td>
</tr>
</tbody>
</table>

Independent strand analysis. There are two stages for the independent strand analysis in this study. The first stage involves traditional analyses specific to each strand methodology with generation of initial analysis results and interpretations. In Stage 2, results were compared across each independent strand. Significant findings were reviewed to generate summarizing
themes related to theory or constructs in the literature. This process was facilitated by placing data in groups to observe how items were related. In pragmatic mixed methods studies, results of independent strand analyses were used to answer research questions that are more oriented towards a particular strand (Morgan, 2014). In this study, a mixed methods analysis was used to examine each of the research questions and determine the value that the mixed methods process brings to the larger body of research.

Integrated analysis. For Stage 3 integrated analysis, rather than relating and grouping data, was conducted using side-by-side visual displays to visualize quantitative and qualitative findings together for merging comparable or relatable data through processes of quantitizing and qualitizing. Merging of data through quantitizing or qualitizing (Guettermann, Creswell, & Kuckartz 2015) occurred by placing independent strand data into grids and determining a new coding system to translate quantitative findings into representative qualitative findings, and qualitative findings into representative quantitative findings.

In this study, quantitizing and qualitizing processes occurred by evaluating data for converging or diverging characteristics, and then overlapping concepts or properties. Visual displays facilitated the merging process by aligning data. For example, quantitative indicators of variance change and survey scores were qualitized into categories of high, medium, and low while qualitized codes were placed in visual displays in ascending or descending order to show inter-item relationships. Multiple relationships revealed from integrated analysis were examined on a macro level in the next stage of pattern analysis.

Pattern analysis, interpretation and inferences. Pattern analysis in Stage 4 requires evaluation of results formed by multiple data intersections. The primary function of pattern interpretation is to consider all findings from various views and perspectives that can show
breadth of relationships in visual pattern alignment or depth of relationships through overlapping layers of meaning. I used three main macro views to facilitate detection of construct of theory pattern designs: (a) pattern one-cognitive processes and epistemic belief theory, (2) pattern two-cognitive processes and attributes of innovativeness theory, and (c) pattern three-epistemic beliefs and attributes of innovativeness theory. Construct of theory patterns are the primary analysis method to display and relate mixed findings to theoretical constructs. Narrative interpretations of each pattern layer and overall pattern display are used to address the research questions and determine research expectations. Inferences from this mixed method analysis address how these findings can be used in various ways for the pragmatic needs of both the research site and larger higher education community. The integrative framework for inference quality (Teddlie & Tashakkori, 2009) was used as a reporting guide to minimize threats to credibility during interpretation and increase inference quality.

**Research question one.** How do faculty epistemic beliefs about assessment of learning change when attending a professional development workshop series on classroom assessment techniques? To answer research question one, an interpretation of pattern three-epistemic beliefs and attributes of innovativeness theory is given and rationale provided for changes that occurred within the measured groups.

**Research question two.** Which cognitive processes are apparent when faculty are making innovative-decisions? Pattern one consisting of cognitive processes and epistemic belief theory and pattern two consisting of cognitive processes and attributes of innovativeness theory were interpreted individually with key narrative indicators that relate to the IM-IDM. This is followed by a focused examination of the pattern formed around the mechanism of action in the IM-IDM.
**Research question three.** What effect do innovativeness and collaborative learning have on epistemic beliefs about assessment of learning when faculty experience the innovation-decision process? The overall pattern map formed by all three construct of theory patterns is used to interpret research question three. This culminating question focused on the strengths and weaknesses of the mixed method analysis used in this study and determines the utility of the IM-IDM research model.

**Human Subjects and Ethical Considerations**

Since a pragmatic view has been taken in the design of the current study, ethical considerations have been observed in determining protocols to solicit the research sample, adherence to institution research policies (including selection of the research team), and minimizing deterrents to faculty roles and responsibilities. Procedures used to carry out this investigation required the researcher to recognize and reduce any biases that may develop from researcher employment at the institution or may generate any potential risk or bias to the research participants of this study. Therefore, the Integrative Framework for Inference Quality (Teddlie & Tashakkori, 2009) was used as a reference throughout this study to minimize research credibility threats.

Study design measures were taken to assure compliance with federal regulations on the protection of human subjects in research. Ethical considerations and integrity protocols were clarified during the selection of study participants including notification of the purpose of the study. Potential risks and benefits from participation were included as well as the opportunity to provide informed consent. Ethical considerations and integrity protocols were clarified during the selection of study participants including notification of the purpose of the study, potential risks and benefits from participation, and being given the opportunity to provide informed consent.
consent. All research participants were informed of the purpose of the study during recruitment and again prior to administration of the focus group discussions. In addition, participants were reminded of their right to decline participation at any time during the study.

Because focus groups are a collaborative process and were conducted by the researchers at the participants’ work environment, the participants were informed at the time of recruitment as well as reminded before discussions were started that complete anonymity could not be achieved in this study. Individual pseudonyms were assigned to all research participants during audio transcription, and personal names or courses mentioned during discussions were de-identified as well. Participant consent forms and electronic SPSS and MAXQDA data base files are currently maintained in a password-protected file on the researcher’s office computer. Only the research team has access to the research computer allocated for use in this study. Members of the research team have their own log in and passwords to maintain interrater integrity. Researcher integrity and professionalism was a priority throughout data analysis, interpretation, and discussion of results. Lastly, the student researcher obtained approval from the Institutional Review Board from the employer institution and graduate institution to assure compliance with all human subjects and ethical considerations.

Summary

Chapter 3 outlined the procedures for selection of study participants, described the mixed methods design, quantitative and qualitative data collection procedures, mixed methods analysis, and use of technology visual displays to interpret patterns and make inferences. Explanations were provided for how each mixed methods analysis answers the research questions and expectations and how the pragmatic research purpose and need to discover greater meaning in faculty decision-making justifies the use of a mixed methods study design. Research
expectations clarified that the study of epistemic beliefs and the innovation decision-making process in the sample population is to be discovered through converging methodologies, and therefore explain how change occurs as faculty consider new information about classroom assessment.
CHAPTER 4: RESULTS

Introduction

The purpose of this convergent parallel mixed methods study was to examine the cognitive processes of epistemic change (i.e., epistemic doubt, epistemic volition, resolution strategies, affect, reciprocal causation, and metacognition) and determine the influence of two professional development teaching strategies (i.e., innovativeness and collaborative learning) on faculty epistemic beliefs, as well as how epistemic change is associated with the innovation-decision process when faculty consider adopting innovative classroom assessment strategies.

This chapter contains the procedures used in the mixed methods analysis to obtain the results. Specifically, this chapter reviews data preparation, descriptive analysis, and instrument validity with the details of the five stages provided in the mixed methods analysis: Stage 1 Independent Strand Analysis, Stage 2 Independent Strand Summary Analysis, Stage 3 Integrated Analysis & Coding, Stage 4 Pattern Analysis, and Stage 5 Interpretation and Inference. Finally, a summary analysis of the mixed methods process is discussed with measures taken to assure credibility using the Integrative Framework for Inference Quality (Teddlie & Tashakkori, 2009).

Data Preparation

The database acquired by permission from the community college institution included raw data in Excel files for four assessment measures (i.e., pre-test and post-test ALEBQ, AIS, and CLQ) administered during workshops provided in spring and fall 2017 semesters. The institution de-identified all participant data prior to transfer of the data files to the researcher’s computer. Table 6 lists the instrument datasets obtained for participants in each series. Numbers listed in parentheses are the final number of data sets retained after data screening.
Table 6. Workshop Database Profile

<table>
<thead>
<tr>
<th></th>
<th>ALEBQ Pre-test</th>
<th>ALEBQ Post-test</th>
<th>AIS</th>
<th>CLQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Series</td>
<td>103</td>
<td>88 (87)</td>
<td>87</td>
<td>87</td>
</tr>
<tr>
<td>Fall Series</td>
<td>90</td>
<td>72 (70)</td>
<td>72 (70)</td>
<td>72 (70)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>193</td>
<td>160 (157)</td>
<td>159 (157)</td>
<td>159 (157)</td>
</tr>
</tbody>
</table>

Notes. ALEBQ = Assessment of Learning Epistemic Beliefs Questionnaire. AIS = Attributes of Innovativeness Survey. CLQ = Collaborative Learning Questionnaire. Numbers in parentheses = data sets retained after cleaning.

Data Screening

The Excel data sets were imported into SPSS version 25 (IBM SPSS INC., 2017) and AMOS software (Arbuckle, 2017). A system of verification or correction (Meyers, Gamst, & Guarino, 2017) was used to compare all values against the original database to ensure accuracy of transfer and reverse order coding. Procedures to study variables for missing values, normality of distributions, and multivariate outliers followed.

Missing data. Three entire pre- and post-test data sets were removed from the ALEBQ database because more than 75% of the values were missing from the post-tests. During independent samples t-test analysis, thirty-three data sets were excluded from the analysis because of missing post-tests using pair-wise deletion. These missing tests correspond with participants who did not attend the final workshop when the post-test was administered. Of the remaining 157 datasets, two pre-tests had a single missing value and one post-test had two missing values. Value replacement occurred by imputation with the median ordinal scale value of five. Data from 159 respondents was collected for both the AIS and CLQ. Two entire sets of data responses were imputed through list-wise deletion during analysis because there were no values for any responses in the data sets. In total, thirty-six (16%) data sets were excluded from the ALEBQ pre/post-test analysis and 1.3% of the AIS and CLQ data sets were excluded. The percentage of exclusions may likely limit generalizability of these findings.
Outliers and normality of distributions. Detection of outliers and tests of normality were conducted through a series of examinations. Frequency charts and boxplots were used to explore for data accuracy and to determine whether existing outliers needed value replacement. Box plots revealed outliers for three responses of the ALEBQ and two responses of the CLQ had exceptionally high values. However, I determined there was no reason to believe these were incorrect values, and there was no theoretical basis for removing them. Thus, outliers were retained as high responses. Tests for normality of distribution were conducted using Z score and Mahalanobis tests, which revealed no univariate and multivariate outliers (Tabachnick & Fidell, 2013b). The skewness and kurtosis of all the measured variables were less than $|2|$, with almost all values falling in an ideal range below $|1|$ (Meyers, Gamst, & Guarino, 2017). This indicated that the scores from this sample could fall into a normal distribution across all variables in the sample (Cohen et al, 2003). In addition to tests for normality and linearity, test for assumptions of homoscedasticity and independence of errors measures preceded multivariate statistical techniques.

Preliminary Analysis

Instruments scales, the values and factors they represent, are the focus of this preliminary analysis. Reliability coefficients for each scale are reported and compared with literature measures. Dependent and independent variable scores across demographic variables, group comparison of analysis covariance are discussed, and procedures of factor analysis are explained in preparation for main structural equation model analyses.

Internal consistency. Estimates of internal consistency calculated for the Assessment of Learning Epistemic Beliefs Questionnaire (ALEBQ) scale compare both the pre- and post-test total scores in each of the four epistemic domain factors (see Table 7). The alpha coefficients for
the pre-test estimates of reliability suggest that source of knowledge (SoK) and justification for knowing (JK) have acceptable levels of internal consistency in the workshop participant sample. However, at the conclusion of the workshop series, ALEBQ post-test measures of internal consistency were acceptable for all epistemic domain factors. These values are consistent with or exceed the values reported for the institution pilot study (Peterson, 2016b) and internal consistency values previously reported for the Topic Specific Epistemic Beliefs Questionnaire (TSEBQ) designed by Braten, Gil, Stromso, and Vidal-Abarca, (2009).

Faculty and administrators at the institution developed the Collaborative Learning Questionnaire (CLQ) and Attributes of Innovativeness Survey (AIS) independent variable measures. Both scales were pilot tested and revealed good internal consistency with Cronbach alpha coefficient values of .86 for total CLQ scores, and subscale constructs of individual development ($\alpha = .86$) and group effectiveness ($\alpha = .83$), which is comparable to the reliability of the original collaborative learning scale (So & Brush, 2008). In the current study, the Cronbach alpha coefficient values were .93 for total CLQ scores, .90 for individual development, and .86 for group development (Peterson, 2016b).

In the Pilot test analysis (Peterson, 2016b), the AIS demonstrated good internal consistency with Cronbach alpha coefficient values of .87 for total scores, relative advantage ($\alpha = .81$), compatibility ($\alpha = .78$), complexity ($\alpha = .63$), trialability ($\alpha = .68$), and observability ($\alpha = .88$). In the current study, the Cronbach alpha coefficient values were similar with .90 for total scores, relative advantage ($\alpha = .72$), compatibility ($\alpha = .78$), complexity ($\alpha = .63$), trialability ($\alpha = .97$), and observability ($\alpha = .75$). These estimates of reliability suggest that the AIS instrument has adequate internal consistency. Factor item inter-correlations are described in detail within discussion of factor analysis processes.
A discussion of how the workshop participants responded as a group to each of the assessment measures is presented next. Table of means, standard deviations, skewness, and kurtosis support a summative evaluation of group performance (i.e., all workshop participants) and subgroup performance (i.e., series of participation and workshop completion). A correlation analysis using total scale scores of the dependent and independent variables were used anticipating a need for a multivariate approach in main analyses (Meyers, Gamst, Guarino, 2017).

<table>
<thead>
<tr>
<th>Subscale/Total Scale</th>
<th>Current Study Pre-test ALEBQ</th>
<th>Current Study Post-test ALEBQ</th>
<th>Pilot Study ALEBQ</th>
<th>Original Measure TSEBQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>.65</td>
<td>.82</td>
<td>.62</td>
<td>(.70)</td>
</tr>
<tr>
<td>SK</td>
<td>.54</td>
<td>.77</td>
<td>.68</td>
<td>(.60)</td>
</tr>
<tr>
<td>SoK</td>
<td>.70</td>
<td>.78</td>
<td>.74</td>
<td>(.71)</td>
</tr>
<tr>
<td>JK</td>
<td>.76</td>
<td>.89</td>
<td>.68</td>
<td>(.71)</td>
</tr>
</tbody>
</table>

Notes. ALEBQ = Assessment of Learning Epistemic Beliefs Questionnaire. TSEBQ = Topic Specific Epistemic Beliefs Questionnaire. CK = Certainty of Knowledge. SK = Simplicity of Knowledge. SoK = Source of Knowledge. JK = Justification for Knowing.

Descriptive Analysis

**Epistemic beliefs.** The ALEBQ uses a 10-point Likert type scale to record self-perception of epistemic beliefs about assessment of learning in four distinct domains: certainty of knowledge, simplicity of knowledge, source of knowledge (SoK), and justification for knowing. Pre- and post-test performance values for each epistemic domain variable are displayed in Table 8. Performance values are grouped by series of participation and workshop completion. Certainty of knowledge (CK) measures how certain one feels that knowledge about assessment of learning is static and unchanging (naïve) or constantly evolving (sophisticated). Higher test scores represent a more sophisticated belief that knowledge changes and varies in interpretation. Lower test scores represent less sophisticated or naïve beliefs indicating knowledge is static with no progression. An increase in sophistication of simplicity of knowledge (SK) would indicate a
turning away from the belief in knowledge as a collection of facts to knowledge as a compilation of highly integrated concepts. Naïve beliefs in justification for knowing (JK) would indicate a tendency to evaluate knowledge from personal experiences or feelings rather than a more sophisticated perspective to use reasoning when considering new knowledge. Greater sophistication in source of knowledge (SoK) beliefs regarding assessment of learning could involve evaluating knowledge presented by the level of authority or expertise of those who are providing professional development, or a strong need for researching the validity of claims made by those presenting professional development content.

Across all four epistemic domains, post-test scores were higher than pre-test scores. For the whole study population, CK showed the largest increase in sophistication of beliefs (24%), whereas JK showed the least (3.7%). This large change in CK suggests that faculty entered the workshop series with a limited or naïve perspective of assessment of student learning. However, that perspective increased in sophistication to become more accepting of a broader scope of understanding and considering ways of assessing student learning because of participating in the workshop series. Participants in the spring cohort had slightly higher pre- and post-test values compared to their fall participant cohorts, and greater increases in CK from pre- to post-test. For this study population, JK pre-scores indicate high baseline levels of sophistication compared to other epistemic domain pre-scores. Therefore, there was less capacity for domain increase in sophistication for the study population. This could be the case when the workshop participants were presented with new or less familiar concepts about classroom assessment during professional development. Simplicity of knowledge showed the second highest change in sophistication of beliefs (11.3%). Increases in sophistication of beliefs regarding the sources of
knowledge are evident by a 9.2% change. Equal to existing baseline sophistication in JK, pre-test performance in SoK showed higher scores and less capacity for increased.

Table 8. Means, Standard Deviations, Skewness and Kurtosis for Epistemic Beliefs

<table>
<thead>
<tr>
<th>Measure ALEBQ</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Skew</th>
<th>Kurt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring Completers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre CK</td>
<td>51</td>
<td>32.14</td>
<td>9.093</td>
<td>.555</td>
<td>.345</td>
</tr>
<tr>
<td>Post CK</td>
<td>51</td>
<td>53.31</td>
<td>5.171</td>
<td>-.865</td>
<td>.564</td>
</tr>
<tr>
<td>Pre SK</td>
<td>51</td>
<td>35.04</td>
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<td>.597</td>
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<td>Post SoK</td>
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<tr>
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<td>Post SoK</td>
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<td>Post JK</td>
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<tr>
<td>Pre CK</td>
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<td>Post JK</td>
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<td>52.60</td>
<td>8.331</td>
<td>.266</td>
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</tr>
</tbody>
</table>

Notes. ALEBQ = Assessment of Learning Epistemic Beliefs Questionnaire. CK = Certainty of Knowledge. SK = Simplicity of Knowledge. SoK = Source of Knowledge. JK = Justification for Knowing.
**Innovativeness.** Participant performance on the independent variable measure for innovativeness is displayed in Table 9. Subscales within the AIS revealed that observability and compatibility showed the highest means across all groups. This suggests that as workshop participants observed the use of a new strategy, it the observation revealed different ways the strategy can be compatible with the teaching practice of the faculty. This could reflect an increased use of the new strategy within their teaching practice. Complexity showed the lowest means. This could suggest that all or most workshop participants did not perceive the innovative assessment technique as complex or that complexity was the least attribute considered in accepting the innovation. It was observed that workshop completers perceived less complexity compared to non-completers suggesting complexity may play a role in workshop persistence.

Table 9. Means, Standard Deviations, Skewness, and Kurtosis for Innovativeness

<table>
<thead>
<tr>
<th>Measure AIS</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Skew</th>
<th>Kurt</th>
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<tr>
<td><strong>Spring Completers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Relative Advantage</td>
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<td>16.47</td>
<td>2.344</td>
<td>-141</td>
<td>.590</td>
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<td>Compatibility</td>
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<td>3.069</td>
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<td></td>
<td></td>
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<tr>
<td>Relative Advantage</td>
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<td>16.92</td>
<td>2.209</td>
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<td>.332</td>
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<tr>
<td>Relative Advantage</td>
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<td>3.117</td>
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<td>.367</td>
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</table>

*Note. AIS = Attributes of Innovativeness Survey.*
Collaborative learning. Perception of collaborative learning was relatively equal across all groups with similar range in scores from 15 to 40. Scores indicate perceptions were in the mid-range of agreement with few scores falling in the range of disagreement. It appears that individuals in the fall completer group perceive a greater benefit from collaborative learning as exhibited by acknowledging higher mean scores in both individual development and group development (see Table 10). Since each cohort was allowed to naturally select their group members for collaborative learning, how these groups differed in their composition and selection processes is a variable not captured in this study. This finding indicates a potential avenue for future study. Differentiation between individual development and group development was not apparent. This indicates that participants were able to perceive their own benefit as well as how they contributed to benefitting their group. However, the measurement items may not have performed well enough for participants to differentiate the effect of each variable. If lack of differentiation between types of development manifest in future studies, the measurement items could be explored for greater specificity.

Table 10. Means, Standard Deviations, Skewness, and Kurtosis for Collaborative Learning

<table>
<thead>
<tr>
<th>Measure CLQ</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Skew</th>
<th>Kurt</th>
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<td><strong>Spring Completers</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual Development</td>
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<tr>
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<td>-1.157</td>
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</table>

Note. CLQ = Collaborative Learning Questionnaire.

Pearson correlation coefficients. Pearson product-moment correlation was used to compare total scale scores of the main variables (i.e., CK, SK, SoK, JK, IN, and CL).
Correlation coefficients were significant at a level of $p < .001$ (two tailed) with a sample number of 157. Strength of relationship was interpreted as $(-/+).30 = \text{weak}, (-/+).50 = \text{moderate}, \text{and} (-/+). strong (\text{Meyers, Gamst,} \text{and Guarino,} 2017).$

Comparing ALEBQ post-test scores, findings revealed only three of the six correlations were statistically significant. Weak to moderate positive relationships exist between JK and CK ($r = .345, n = 157, p < .001$) and between SoK and SK ($r = .286, n = 157, p < .001$), and between SoK and JK ($r = .248, n = 157, p < .001$). This suggests those who examine constructs along with others and develop their own understanding may also perceive knowledge as integrated concepts of varying complexity. Likewise, those that value inquiry as persistent learning are likely to structure their learning through reasoning to examine and validate knowledge.

Comparing the independent and dependent variables, a moderate positive relationship was found between innovativeness (IN) and CK ($r = .561, n = 157, p < .01$) and weak positive relationships were found between IN and JK ($r = .261, n = 157, p < .01$) and very weak positive relationship between IN and SK ($r = .125, n = 157, p < .01$). This suggests that individuals who recognize and value knowledge as evolving may perceive the knowledge as innovative. They may also start to perceive how innovations can be integrated into their existing knowledge by weighing and judging the attributes of the innovation. Last, comparing the independent variables, a weak moderate positive relationship exists between collaborative learning (CL) and IN ($r = .382, n = 157, p < .001$) suggesting that those who perceive a benefit in a collaborative style of learning may also recognize and value the attribute of innovativeness in the knowledge that is discussed and shared within collaborative groups. These relationships warrant further investigation in main analyses to determine what effects exist among the variables. Although literature reveals epistemic beliefs to be inter-related yet separate dependent variables, findings in this study reveal
three epistemic belief correlations of the six were uncorrelated. Meyers, Gamst, and Guarino (2017) state that multivariate analysis “is most efficient with moderate correlations (in the range of .6) among the dependent variables” (p. 770). Therefore, I elected to compare differences of effect between the four epistemic domains through an analysis of variance design using a smaller alpha level with greater confidence rather than use multivariate analysis.

**Analysis of covariance.** Analysis of covariance (ANCOVA) was selected to conduct mean comparison tests with two different workshop population groups (i.e., series of participation and workshop completion status) to determine whether the mean change in post-tests differed within the groups while controlling for any effect of the pre-test. ANCOVA tests were conducted with epistemic belief subscale scores from the Assessment of Learning Epistemic Beliefs Questionnaire (ALEBQ) as separate dependent variables. Administration of the post-test occurred following completion of the workshop series (Time 2). Epistemic belief scores on the ALEBQ administered prior to the commencement of the workshop series (Time 1) was used as a covariate to control for individual differences. Alpha was set at 98.75% confidence interval to reduce the possibility of type one error. Series of participation (i.e., spring or fall) and workshop completion (i.e., completer or non-completer) were set as between subjects factors. Preliminary checks were conducted comparing mean pre-test scores between each group to ensure that there was no violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliability measurement of the covariate. The analysis process included examination of the univariate effect for each dependent variable. A simple effects analysis was conducted using independent samples t-test with Bonferroni correction at the .0125 level to determine the effect of change that occurred in the dependent variables for each group (see Table 11). A final comparison of original mean scores and
adjusted mean scores was conducted to reveal the effect of the pre-test variance on post-test scores (see Table 12).

**Series of participation.** After adjusting for the influence of pre-test scores, there was a statistically significant effect in certainty of knowledge (CK), $F(1,154) = 47.507, p < .001$ indicating differences between spring series participants (adjusted $M = 51.21, SE = .762, 98.5\% CI = 49.275, 45.456$) and fall series participants ($M = 43.308, SE = .850, 98.5\% CI = 41.161, 45.456$). A look at adjusted mean scores revealed greater increases in sophistication of CK beliefs with spring series participants compared to fall series participants. Therefore, a simple effects analysis was conducted to determine the amount of variance explained by the pretest in the effect. Findings revealed the effect of the covariate on sophistication in CK beliefs was not statistically significant $F(1,154) = .013, p < .911$. However, simple effect analysis indicated a statistically significant difference in sophistication of CK by the end of the workshop, $F(1,155) = 3.586, p < .001$, eta squared $= .239$. This effect suggests knowledge gained at the workshop may have affected change in simplicity of knowledge beliefs about assessment of learning.

Moreover, according to Cohen (1988) eta squared effects can be interpreted as $.01 = $ small effect, $.06 = $ medium effect, and $.14 = $ large effect.

Examining simplicity of knowledge (SK), $F(1,154) = 37.128, p < .001$, there were statistically significant differences between fall series participants (adjusted $M = 51.402, SE = .618, 98.5\% CI = 50.181, 52.622$) and spring series participants ($M = 46.343, SE = .554, 98\% CI = 45.249, 47.438$), and no statistically significant effect of the covariate on SK, $F(1,154) = .043, p < .835$. Looking to simple effect analysis, statistically significant changes in SK epistemic beliefs occurred as well, $F(1,155) = 1.944, p < .001$, eta squared $= .194$ indicating the change effect was not influenced by participants’ prior knowledge.
There was no statistically significant differences between spring and fall participant scores for source of knowledge (SoK), $F(1,154) = .176, p = .676$ or for justification for knowing (JK), $F(1,154) = 2.249, p = .136$. In addition, there was no statistically significant effect of the pre-test on the observed increased sophistication of SoK beliefs, $F(1,154) = 2.944, p = .088$ or sophistication of JK beliefs, $F(1,154) = .990, p = .321$. A follow up simple effects analysis was conducted and findings indicated no statistically significant effect of change in SoK beliefs $F(2,155) = .003, p = .565$, or in JK beliefs $F(2,155) = .025, p = .124$.

The magnitude of differences in the means for both CK and SK epistemic beliefs in this analysis was large. It appears that the large effect of increased sophistication of CK epistemic beliefs for spring participants and SK epistemic beliefs for fall participants was not influenced by the workshop participant’s prior knowledge of assessment of learning. Further, learning about CATs during the workshop series may have caused greater sophistication in certainty of knowledge epistemic beliefs for spring participants and simplicity of knowledge epistemic beliefs for fall participants.

**Workshop completion.** ANCOVA analyses produced similar results for investigating workshop completion. Controlling for influence of the covariate, there was no statistically significant difference between group score between completers and non-completers for certainty of knowledge (CK), $F(2,154) = 4.248, p = .041$ at a 98.75% confidence level, and no statistically significant effect of the covariate on increased sophistication of CK beliefs, $F(2,154) = 1.011, p = .319$. Simple effects analysis of change in CK epistemic beliefs revealed statistically significant differences among workshop completion groups for SK beliefs, $F(2,154) = 14.220, p = .001$, and for SoK beliefs, $F(2,154) = 7.327, p = .008$, and for JK beliefs, $F(2,154) = 30.088, p = .001$. Completers showed statistically significant mean score increases for SK beliefs (adjusted
\( M = 49.838, SE = .549, 98.5\% CI = 48.753, 50.923 \) compared to non-completers (adjusted \( M = 46.364, SE = .738, 98.5\% CI = 44.906, 47.822 \) no statistically significant effect of the covariate on increased sophistication of CK beliefs, \( F(2,154) = 1.011, p = .319 \). Follow up analysis with an independent t-test revealed a statistically significant difference in effect of epistemic change for SK beliefs, \( F(1, 154) = 4.986, p = .001 \), \( \eta^2 = .084 \). Likewise, the measure of epistemic change for SoK beliefs was statistically significant for completers (adjusted \( M = 41.548, SE = .554, 98.5\% CI = 40.455, 42.642 \)) compared to non-completers (adjusted \( M = 39.029, SE = .745, 98.5\% CI = 37.557, 40.500 \)). No statistically significant effect of the covariate on increased sophistication of SoK beliefs, \( F(2,154) = 2.208, p = .139 \) was found.

Examining increased effect of SoK belief change, results were statistically significant \( F(1,154) = .065, p = .005 \), \( \eta^2 = .05 \), but revealed a small effect. For JK, a statistically significant increase in mean scores was also found for completers (adjusted \( M = 61.589, SE = .758, 98.5\% CI = 60.093, 63.086 \)) compared to non-completers (adjusted \( M = 54.634, SE = 1.017, 98.5\% CI = 52.624, 56.644 \)). However, no statistically significant effect of the covariate on increased sophistication of JK beliefs, \( F(2,154) = 1.451, p = .230 \) with simple effects analysis revealing a significant increase in justification for knowing with completers \( F(2,154) = .073, p = .001 \), \( \eta^2 = .16 \) and large effect.

Overall, the results of the ANCOVA analyses for completers versus non-completers indicated that existing epistemic beliefs in all four domains and prior knowledge of assessment of learning did not have a statistically significant effect. The change in sophistication of epistemic beliefs appears to be attributed to the influence of the new knowledge provided in the workshop content. Further investigation of direct and indirect effects occur in the main
quantitative analyses of this study. Next, the measurement instruments were investigated further
to determine instrument validity and goodness of fit in preparation for the main analyses.

Table 11. Effects of Change in Epistemic Beliefs Controlling for Pre-test Knowledge

<table>
<thead>
<tr>
<th>Series of Participation</th>
<th>Workshop Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV</td>
<td>Eta²</td>
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<tr>
<td>CK</td>
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<tr>
<td>SK</td>
<td>.19*</td>
</tr>
<tr>
<td>SoK</td>
<td>.01</td>
</tr>
<tr>
<td>JK</td>
<td>.02</td>
</tr>
</tbody>
</table>


Table 12. Original and Mean score Change by Series and Completion

<table>
<thead>
<tr>
<th>Workshop Groups</th>
<th>Original Mean Scores</th>
<th>Adjusted Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>F</td>
</tr>
<tr>
<td>DV</td>
<td>CK</td>
<td>51.21</td>
</tr>
<tr>
<td></td>
<td>SK</td>
<td>46.34</td>
</tr>
<tr>
<td></td>
<td>SoK</td>
<td>40.41</td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>60.02</td>
</tr>
</tbody>
</table>


**Exploratory factor analysis.** Exploratory factor analysis (EFA) of the ALEBQ, CLQ, and AIS items was conducted to determine the nature and number of latent variables that account for observed variation and covariation among items. In addition, I wanted to determine whether the indicator variables for each of the latent variables were potentially going to work well and support a structural measurement model to research variable effects. An exploratory approach was selected because the CLQ, AIS, and ALEBQ had been pilot tested by the institution, but full validity analysis of the theoretical constructs had not been conducted. The literature showed all four epistemic domains load as separate factors. The CLQ measures two separate constructs of individual development and group development and AIS measures five separate constructs of relative advantage, compatibility, complexity, trialability, and observability. Maximum
likelihood with promax rotation was used to determine if the 11 observed variables: (a) would load together as expected, (b) were adequately correlated, and (c) met criteria of reliability and validity. Each of these processes are discussed below.

Independent EFAs of each measurement scale were produced first in a preliminary analysis using a Kaiser-Guttman criterion of greater than one to allow free loading of factors. Viewing the pattern matrix, all eight items of the CLQ loaded as a single factor with loadings ranging from .317 to .992. Likewise, all 12 items of the AIS scale loaded as a single factor ranging with loadings from .372 to .928. The ALEBQ is a topic-specific modification of the four factor TSEBQ with established measures of reliability and validity (Braten, Gil, Stromso, & Vidal-Abarca, 2009). It was expected that all four epistemic domains would present as individual factors. However, SoK items all cross-loaded in the other epistemic domain factors with pattern coefficients ranging from .26 to .51.

Next, the ALEBQ, AIS, and CLQ scales were combined and subjected to EFA with maximum likelihood method and promax rotation. The first analysis attempted to extract 11 factors, but yielded no local minimum and 100 percent of the variance was explained. An inspection of the screeplot revealed a clear break after the fifth component, so a second analysis was conducted specifying a five-factor solution. The second analysis produced eigenvalues (Factor 1 = 5.836, Factor 2 = 4.807, Factor 3 = 5.487, Factor 4 = 3.172, and Factor 5 = 2.519) explaining 13.264%, 10.925%, 12.470%, 7.209%, and 5.725% of the variance respectively. The Kaiser-Meyer-Oklin value of .740 exceeded the recommended value of .6 (Kaiser, 1970; 1974) and Bartlett’s test of sphericity (Bartlett, 1954) reached statistical significance, supporting the factorability of the correlation matrix. Several coefficients exceeded .4 in the correlation matrix and almost all items loaded in the five-factor model with values at .4 or higher. The items
associated with each subscale, factor loadings, communality estimates, means, and standard deviations are summarized in Appendix K.

Factor one represents the collaborative learning teaching strategy used in the workshop to supplement delivery of the new knowledge about classroom assessment techniques. Collaborative learning involved groups of five to seven faculty actively discussing and applying presented material to group and individual projects. Factor two represents innovativeness as an awareness of the value and attributes of an item. The attributes of CAT innovativeness was the focus of the workshop series. Classroom assessment techniques was communicated to faculty in the workshops as a new way of thinking and using assessment in the classroom rather than the traditional context of assessing learning through final exams and course grades. Thus, five attributes of innovativeness were emphasized as valued reasons to adopt the innovation CATs (relative advantage, compatibility, complexity, trialability, and observability). Factor three, four, and five were identified as three of the four epistemological belief domains: justification for knowing, certainty of knowledge, and simplicity of knowledge. The fourth epistemic domain source of knowledge cross-loaded or individually loaded within the other three epistemic domains.

Three criteria were used for inspecting and retaining scale items for model re-specification (a) factor loadings of .5 or greater; (b) items loading saliently with a value of .4 or higher on more than one rotation; and (c) retaining factors that had at least three item loadings. Items that did not load above .4 were removed from the model including six items from the ALEBQ that measures epistemic beliefs (SoK 2, 3, 4, & 5, CK 6, and SK 6), one item from the CLQ that measures collaborative learning (CL 7), and two items from the AIS that measures innovativeness (IN 1 & 12). Seven additional items loaded between .4 and .5. The content of
these items were evaluated and it was determined (a) items were closely related to another item with a higher loading value and (b) items manifested cross loadings above .3 and had low communality estimates. Therefore, three items measuring innovativeness from the AIS (IN2, IN3, and IN7) and four items measuring epistemic beliefs from the ALEBQ (JK 1 and 5, SoK 1, and SK 5) were deleted.

Of the four epistemic domains, none of the items for SK loaded as a distinct factor or loaded above. Thus, in this study, source of knowledge could not be explored as a valid quantifiable factor. However, source of knowledge is addressed in the qualitative analysis of cognitive processes. Of the six items that measured certainty of knowledge, only one item did not meet the requisite .4 loading threshold to be retained. Both justification and simplification scales were reduced by two items each. The final five-factor model explained 72.2% of the variance.

In anticipation of building a structural model to determine effects among observed variables, I employed a strategy to bolster the measurement model advocated as a two-step approach (e.g., Mulaik & Millsap, 2000; Schumacker & Lomax, 2016). A strategy of using EFA prior to confirmatory factor analysis (CFA) is conducted when a model is projected to be configured based on a theoretical framework that is the research focus (Myers, Gamst, & Guarino, 2017). Initial EFA helped to determine weak indicators for the given latent variables and cross-loading variables early on. EFA provided the opportunity of excluding those variables at the outset. In particular, variables known to load well or distinctly in previous studies that cross-load or load strongly as another variable can be eliminated as a nonviable variable after EFA (Myers, Gamst, & Guarino, 2017). My intent was to create less need for model re-specification by eliminating factors and create greater direct alignment of model fit without the
need for replacing correlation paths with directional paths (Myers, Gamst, & Guarino, 2017). Considering that SoK did not load as expected in EFA (Braten, Gil, Stromso, & Vidal-Abarca, 2009) and epistemic beliefs were central to the theoretical framework of this study, I conducted CFA after EFA to (a) establish convergent and discriminant validity, and (b) determine reliability of measurement items. Measurement items included the three domain factors of justification for knowing, certainty of knowledge, and simplification of knowledge, as well as the single factor of collaborative learning, and single factor of innovativeness.

**Confirmatory factor analysis.** Three types of fit indexes were computed to test the model for goodness of fit. Absolute indexes include chi-square statistic, ratio of chi-square to the degree of freedom, root mean square error of approximation (RMSEA), and goodness of fit index (GFI). Relative indexes include comparative fit index (CFI), Normed Fit Index (NFI), Incremental Fit Index, and Tucker-Lewis Index (TLI).

An initial test of CFA yielded pattern coefficients relating the factors with items in a range from .58 to .99 and a statistically significant chi square test with a value of 885.014 (340, \(N = 157\), \(p = .001\). However, the GFI (.713), IFI (.974), TLI (.861), CFI (.844), GFI (.860) and RMSEA (.101) all indicated a poor fit. Eleven minor modifications of correlation errors were suggested. I chose to incorporate all eleven modifications since question items were closely related modifications would reduce redundancy in the model. The re-specified model was tested and exhibited a statistically significant Chi square value of 423.184, (328, \(N = 157\), \(p = .000\), where cmin/df = 1.290 was good. The GFI (.847) absolute indicator was not greater than .95 indicating poor fit, but IFI (.976), TLI (.972), and CFI (.976), were all above .95 and indicated good relative fit. AGFI (.810) was above .80, PCLOSE (.831) is greater than .05 and not
statistically significant, and RMSEA (.043) was less than .05. Next, the model was subjected to final tests of validity and invariance between groups.

Tests of validity and invariance. Convergent and discriminant validity, as well as reliability, were established for the CFA model. Table 13 illustrates evidence of convergent validity by all the Averaged Variance Extracted (AVE) correlations manifesting above a threshold of .5 (Hair, Black, Babin, & Anderson (2010); Composite Reliability (CR) was established with correlations greater than .7 (Hair, Black, Babin, & Anderson (2010), and discriminant validity was evident by the square root of the AVE being greater than the inter-construct correlations (Hair, Black, Babin, & Anderson (2010).

Test for measurement invariance between series. A multi-group measurement model comparison was conducted to check for invariance between spring series and fall series on corresponding parameters. Contrasted to the unconstrained model, the chi square difference test for the measurement weights model yielded a statistically significant value of 59.132, (23, \(N = 157\), \(p < .001\). This indicated that there might be differences between the spring and fall series with respect to pattern coefficients associating one or more of the indicator variables to their factors. However, because the study population (\(N = 157\)) was small, independent analyses of each group could not be computed to detect specific differences. Therefore, series was not included as a differentiating exogenous component in the structural model.

Table 13. CFA Validity and Reliability

<table>
<thead>
<tr>
<th>Factor</th>
<th>CR</th>
<th>AVE</th>
<th>MSV</th>
<th>ASV</th>
<th>CK</th>
<th>CL</th>
<th>IN</th>
<th>JK</th>
<th>SK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certainty of Knowledge</td>
<td>.835</td>
<td>.504</td>
<td>.059</td>
<td>.841</td>
<td>.710</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>.960</td>
<td>.778</td>
<td>.008</td>
<td>.996</td>
<td>.031</td>
<td>.882</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovativeness</td>
<td>.876</td>
<td>.641</td>
<td>.011</td>
<td>.919</td>
<td>.022</td>
<td>.092</td>
<td>.801</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justification</td>
<td>.888</td>
<td>.580</td>
<td>.059</td>
<td>.979</td>
<td>.242</td>
<td>.082</td>
<td>.080</td>
<td>.761</td>
<td></td>
</tr>
<tr>
<td>Simplicity</td>
<td>.840</td>
<td>.573</td>
<td>.021</td>
<td>.872</td>
<td>-1.146</td>
<td>.054</td>
<td>-1.107</td>
<td>.121</td>
<td>.757</td>
</tr>
</tbody>
</table>

Notes. CR = composite reliability. AVE = average variance extracted. MSV = maximum shared variance. ASV = average shared variance. CK = certainty of knowledge. CL = collaborative learning. IN = innovativeness. JK = justification for knowing. SK = simplicity of knowledge.
Stage One Independent Strand Analysis

Stage one analyses included procedures of the quantitative strand main analysis of structural equation modeling to test for effects between the independent variables of CAT innovativeness and group collaborative learning on the dependent latent variable of epistemic beliefs (i.e., certainty of knowledge, simplicity of knowledge, and justification for knowing). This discussion is followed by an overview of the processes conducted in the qualitative strand analyses (i.e., open coding, construct coding, and magnitude coding) used to explore the cognitive processes that occur in faculty innovation decision-making.

Quantitative strand. Structural Equation Modeling (SEM) was selected for main quantitative analysis to study the structural relationship of the independent and dependent variables as latent factors represented through three measurement instruments (i.e., ALEBQ, CLQ, AIS). I used a three-step approach to (Schumacker & Lomax, 2016) strengthen the quality of data used for structural equation modeling (SEM). The first two steps of EFA and CFA occurred in the preliminary analysis to generate a good measurement model so the measurement items genuinely represented the latent variables, and so the design of the model accurately reflected the variable relationships (Meyers, Gamst, Guarino, 2017). The SEM configured for this study derives from the data of the 193 original workshop participants in the study population. The CFA model was configured into a structural model to explore direct and indirect effects of the workshop variables (see Figure 7). To assist with path direction, I reviewed the Pearson correlation relationships from descriptive analysis.

I positioned the three latent variables of JK, CK, and SK in the structural model as endogenous outcome variables, whereas IN and CL are positioned as exogenous latent variables. This model design was created to be comparable to the role of the independent and dependent
variables in the IM-IDM theoretical model (see Figure 10). The literature shows that epistemic beliefs function as independent factors, but they are inter-related in purpose (Hofer & Pintrich, 2000; Bendixen & Rule, 2004). Thus, I connected the three epistemic factors by direct effect lines in a reciprocal loop. The structural portion of the model suggests the interrelationships between variables. The model design explores whether the independent variables (i.e., IN and CL) have direct and indirect effects on the dependent variables (i.e., JK, CK, and SK). In addition, the model also explores if mediation relationships exist within the model. A description of the procedures used for model analyses and subsequent follow-up analyses follow along with summary charts of the effects discovered, their significance, and a synthesis of results.

**SEM analysis for direct and indirect effects.** The SEM was examined initially for direct effects among all observed variables, and to determine whether the variables in the designed model produced reasonable squared correlation coefficients. Although the model did have good fit, the model configuration only accounts for approximately 13% ($R^2 = .132$) of the explained variance of epistemic beliefs, which indicates a strong likelihood that other variables may be unaccounted for in the model. The analysis reveals that the pattern coefficients linking the measured variables to their latent variables do not have any statistically significant direct paths from IN and CL to the three epistemic belief latent factors (see Table 14). However, SEM did reveal statistically significant path coefficients between each of the three epistemic belief latent factors. While each epistemic factor loaded independently from one another in CFA, this analysis shows each has a direct effect on the other. It was possible that IN and CL were not related to epistemic beliefs, but more likely considering the theoretical framework of the Integrated Model (IM) for epistemological development (Bendixen & Rule, 2004), there was a
potential for complete mediation within the full model. It was also plausible that the model configuration itself did not represent the theoretical constructs well and the design configuration was not a good representation of the IM-IDM. Each of these considerations warranted follow-up analyses for mediation.

Figure 7. SEM Analysis of Effects on Epistemic Beliefs

*Notes.* IN = innovativeness. CL = collaborative learning. JK = justification for knowing. CK = certainty of knowledge. SK = simplicity of knowledge.

**SEM analysis for mediation.** Direct and indirect effects of all variables within the SEM were examined for mediation with IN and CL as predictors. Mediation was tested using 2000 bias corrected bootstrapping resamples at 95% confidence level in AMOS. Direct and indirect effects were examined for potential partial and complete mediation. Examination of direct
effects first occurred in an unmediated model, then in a mediated model. I observed path coefficients to see if direct effects would drop. Complete mediation was determined if indirect effects were statistically significant along with a statistically significant direct effect in an unmediated model. Partial mediation was determined if statistically significant effects were found in both direct and indirect effects.

Table 15 displays the results of mediation effects among epistemic belief variables. Analysis of all standardized path coefficients revealed no statistically significant mediation pathways. Therefore, I deleted IN and CL from the model and ran a series of separate analyses with each epistemic belief variable placed in the model as a predictor to explore if mediation effects existed within epistemic beliefs (see Appendix M). The path from JK to SK (standardized coefficient = .131, unstandardized coefficient = .135 with a standard error of 0.068, \(p = .048\)) was statistically significant (see Table 16). JK does not appear to directly affect SK in the configured model, but did so indirectly through CK. The relative strength of this indirect effect is -.044 or 4% of the total effect of JK on SK. Since an indirect effect is a product of a distal and proximal mediation path, Hoyle and Kenny (1999) recommend classifying effect size by \(r\) (.01 = small effect, .09 = medium effect, .25 = large effect). Thus, the effect size of JK on SK is small. Because the unmediated direct effect and mediated direct effect were not statistically significant it does not appear that partial or complete mediation exists and therefore follow-up analyses were not conducted. It appears that low power in this study is affecting the size of the direct path coefficients and lack of statistical significance, but when combining the distal and proximal direct path coefficients together a statistically significant indirect effect is achieved. Thus, it is possible that a larger sample could generate enough power to determine a mediation effect for this pathway and others in the model.
Table 14. SEM Analysis Properties

<table>
<thead>
<tr>
<th>Pathways</th>
<th>Estimate</th>
<th>S.E.</th>
<th>C. R.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>JK &lt;- IN</td>
<td>.179</td>
<td>.129</td>
<td>1.392</td>
<td>.164</td>
</tr>
<tr>
<td>CK &lt;- IN</td>
<td>-.011</td>
<td>.108</td>
<td>-1.098</td>
<td>.922</td>
</tr>
<tr>
<td>SK &lt;- IN</td>
<td>-.125</td>
<td>.104</td>
<td>-1.198</td>
<td>.231</td>
</tr>
<tr>
<td>JK &lt;- CL</td>
<td>.047</td>
<td>.054</td>
<td>0.876</td>
<td>.381</td>
</tr>
<tr>
<td>CK &lt;- CL</td>
<td>.006</td>
<td>.046</td>
<td>.133</td>
<td>.894</td>
</tr>
<tr>
<td>SK &lt;- CL</td>
<td>.038</td>
<td>.044</td>
<td>.874</td>
<td>.382</td>
</tr>
<tr>
<td>CK &lt;- JK</td>
<td>.214</td>
<td>.075</td>
<td>2.869</td>
<td>.004**</td>
</tr>
<tr>
<td>SK &lt;- CK</td>
<td>-.188</td>
<td>.098</td>
<td>-1.925</td>
<td>.054**</td>
</tr>
<tr>
<td>JK &lt;- SK</td>
<td>.236</td>
<td>.122</td>
<td>1.935</td>
<td>.053**</td>
</tr>
</tbody>
</table>


Table 15. Effect of Innovativeness and Collaborative Learning on Epistemic Beliefs

<table>
<thead>
<tr>
<th>Paths</th>
<th>Direct Beta w/o Med</th>
<th>Direct Beta w/Med</th>
<th>Indirect Beta</th>
<th>Mediation type observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK &lt;- JK &lt;- IN</td>
<td>.160 (ns)</td>
<td>-.009 (ns)</td>
<td>-.020 (ns)</td>
<td>No Mediation</td>
</tr>
<tr>
<td>SK &lt;- CK &lt;- IN</td>
<td>.027 (ns)</td>
<td>-.105 (ns)</td>
<td>.026 (ns)</td>
<td>No Mediation</td>
</tr>
<tr>
<td>JK &lt;- SK &lt;- IN</td>
<td>-.125 (ns)</td>
<td>.116 (ns)</td>
<td>-.003 (ns)</td>
<td>No Mediation</td>
</tr>
<tr>
<td>CK &lt;- JK &lt;- CL</td>
<td>.059 (ns)</td>
<td>.071 (ns)</td>
<td>.012 (ns)</td>
<td>No Mediation</td>
</tr>
<tr>
<td>JK &lt;- SK &lt;- CL</td>
<td>.033 (ns)</td>
<td>.075 (ns)</td>
<td>-.007 (ns)</td>
<td>No Mediation</td>
</tr>
<tr>
<td>SK &lt;- CK &lt;- CL</td>
<td>.018 (ns)</td>
<td>.011 (ns)</td>
<td>.022 (ns)</td>
<td>No Mediation</td>
</tr>
</tbody>
</table>

Note. (ns) = not significant. IN = innovativeness. CL = collaborative learning. JK = justification for knowing. CK = certainty of knowledge. SK = simplicity of knowledge.

Table 16. Mediation Effects among Epistemic Beliefs

<table>
<thead>
<tr>
<th>Paths</th>
<th>Direct Beta w/o Med</th>
<th>Direct Beta w/Med</th>
<th>Indirect Beta</th>
<th>Mediation type observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK &lt;- JK &lt;- SK</td>
<td>-.151</td>
<td>-.183 **</td>
<td>.034</td>
<td>No Mediation</td>
</tr>
<tr>
<td>JK &lt;- CK &lt;- SK</td>
<td>.160</td>
<td>.169</td>
<td>-.038</td>
<td>No Mediation</td>
</tr>
<tr>
<td>JK &lt;- SK &lt;- CK</td>
<td>.295 **</td>
<td>.258 **</td>
<td>-.025</td>
<td>No Mediation</td>
</tr>
<tr>
<td>SK &lt;- JK &lt;- CK</td>
<td>-.141</td>
<td>-.188</td>
<td>.041</td>
<td>No Mediation</td>
</tr>
<tr>
<td>CK &lt;- SK &lt;- JK</td>
<td>.188 **</td>
<td>.260 **</td>
<td>-.024</td>
<td>No Mediation</td>
</tr>
<tr>
<td>SK &lt;- CK &lt;- JK</td>
<td>.094</td>
<td>.176</td>
<td>-.044 **</td>
<td>No Mediation</td>
</tr>
</tbody>
</table>

Note. (ns) = not significant. IN = innovativeness. CL = collaborative learning. JK = justification for knowing. CK = certainty of knowledge. SK = simplicity of knowledge. ** = p < .05

SEM summary analysis. SEM analysis could not determine any direct effects of IN or CL on epistemic beliefs. However, direct effects were found between the latent variables of epistemic beliefs. In tests for mediating effects, direct and indirect effects were found between
epistemic beliefs, yet no statistically significant mediating effects were revealed. Thus, SEM analysis could not determine any statistically significant effects in this study to account for the independent and dependent variables identified in the IM-IDM. These results taken together indicate a strong need for greater power to determine whether the hypothesized model and relationships between variables does fit with theorized components of the IM-IDM where IN and CL can explain a portion of the effect occurring in epistemic change.

Quantitative strand summary. No statistically significant direct and indirect effects of the dependent and independent variables could be determined through main analysis of SEM. However, findings from descriptive and ANCOVA analyses indicate workshop participants increased sophistication of all epistemic beliefs. Generally, workshop participants selected item responses from the upper end of the Likert scale indicating strong agreement with IN and CL concepts. The increases in sophistication of epistemic beliefs manifested as small, moderate and large effects. These findings together support the influence of the workshop concepts on the epistemic beliefs of all participants. However, causal effects could not be determined. Therefore, I chose to focus on the statistically significant findings from ANCOVA analysis moving forward to the second stage of independent strand analysis. Next, the second stage of independent strand analysis follows with a description of the qualitative methods.

Qualitative strand. The qualitative analysis for stage one includes procedures used to manage and transcribe the focus group audio recordings, procedures used for transcription and analysis in MAXQDA Pro software (MAXQDA, 2018) that include first and second round coding procedures, paraphrasing, and memos. Next, I provide a description of preliminary procedures of coding preparation, essential data management, and transcription procedures, and
then I follow with a discussion of participant response to the focus group questions and overview of the independent strand analysis.

**Coding preparation.** Each focus group audio recording was transcribed using MAXQDA Pro audio text processor. Summary notes recorded at each focus group session were incorporated during transcription to assist in assigning respondents with fictitious identifiers. Coding was conducted through MAXQDA Pro software: therefore, codes, sub-codes, memos, and notes were auto-generated into a codebook (see Appendix N). Two members of the research team reviewed the transcription process for entry and formatting errors. Calibration among the research team involved reviewing code definitions, determining coding criteria, and conducting coding procedures with a preliminary side-by-side standardization practice session. Thereafter each researcher performed independent coding of assigned transcripts. We conducted a final collaborative review of coded transcripts to identify coded segments within each set of context codes that were not at least, partially coded by two other researchers. Coder adjudication involved intensive group discussion of discrepancies to gain simple consensus (Brinkmann & Kvale, 2015, 2015; Harry et al., 2005; Sandelowski & Barroso, 2007). A transcript was prepared and coded for each focus group. A sample focus group transcript is shown in Appendix O.

**Coding and analysis.** The initial stages of coding and analysis consisted predominantly of concept coding derived from the theoretical concepts outlined in the IM-IDM model. Concept coding was essential for a pragmatic exploration of the innovation-decision-making phenomenon in a mixed-methods inquiry. A coding system and codes were developed for four concept categories: epistemic beliefs, cognitive decision-making processes, collaborative learning, and attributes of innovativeness. The coding process consisted of two techniques, line-by-line
analysis, and lexical search code analysis within the MAXQDA Pro mixed methods software. Prior to coding, short definitions were agreed-upon by the research team as comparative indicators of the concepts. The comparative indicators were embedded into a code memo note in the software so researchers could frequently access the indicator reference during the coding process and maintain standardization of interpretation. The concept coding process consisted of comparing all question responses within a focus group to defined indicators of a particular cognitive concept. The use of a lexical search as a final keyword search for coding helped find specific terms that manifested in question responses, but had not yet been accounted for in other coded segments. Then all retrieved words across the four focus group documents were viewed individually to determine how the word was embedded within a sentence or paragraph. Each sentence segment surrounding the search word was evaluated for inclusion in the coding process. Each researcher conducted a minimum of two rounds for each coding category, and for each of the four focus group transcripts.

Members of all four groups were relatively homogenous in alternating responses to the questions asked by the moderator. However, as is expected with focus groups, some group members participated more in discussion than others, and some participants provide greater dialog in response to questioning (Morgan, 2014). A segment of coded data is provided to illustrate the layout of the focus group transcript, differentiation of codes, and concept code memos used to reference the coding indicators utilized in first round coding (see Figure 8).

During coding adjudication, the researcher found it easier to gain consensus in coding epistemic beliefs, collaborative learning strategy, and attributes of innovativeness in comparison to the cognitive processes of decision-making. Although researchers were calibrated, there was large variation in responses to the focus group questions. Often respondents did not directly or
completely answer the question(s) asked by the moderator. Because the researchers did not want to influence the focus group participants thinking about their cognitive thinking processes, the decision was made not to provide a definition of cognitive terms handout at the focus group sessions. This may have contributed to participant confusion in responses or hesitance to participate and respond.

Figure 8. Focus Group Transcript Coding

Figure 9 illustrates coding percentages across cognitive processes. Emotion was the primary detectable response that was easiest for participants to understand and discuss (33.6%). Processes of metacognition and reciprocal causation that involved recognizing how others may influence change in your beliefs and decisions was the least manifest in discussion. There was substantial discussion about the effectiveness or ineffectiveness of collaborative learning used in the workshops as a strategy of learning, yet why and how the group participation and interaction was having an effect on their epistemic beliefs, decision-making, and learning was rarely evident. A final round of code merging and cross-coding validation was conducted before proceeding with round two coding.
Second round coding and analysis. Magnitude coding of group dynamics and determination of summary themes for each innovation-decision process was conducted with each focus group. Magnitude coding captured related dynamics that enhanced the dialog such as frequency of response, intensity of response, or sentiment of positive or negative support. These sometimes appeared as non-verbal cues or repeated verbal cues (Saldana, 2016). A magnitude-coding rubric was constructed for each researcher to use in evaluating transcripts. Coding described group behavior in general. Categories for magnitude codes include (a) frequency of responses to a question and frequency of respondents sharing the same opinions (0- Not at all, 1- Once, 2- Twice, 3- Three or more); (b) general direction or disposition of the group response, (1- Negative, 0- Neutral, 1- Mixed, 2- Positive); and (c) strength or emphasis in response to an issue (0- Not evident, 1- Low, 2- Moderate, 3- High.) Magnitude coding rubrics were collected from each research team member and inter-rater discrepancies were adjudicated before manually entering a consensus rating for each focus group question into the software. The next section describes the processes of analysis applied to the focus group discussions.

Analysis of Group Discussion. The qualitative strand inquiry primarily focuses on determining where epistemic beliefs, collaborative learning, and attributes of innovations manifest in faculty discussion of their innovation-decision-making process in response to ten questions
1. How did the knowledge about CATs cause you to reconsider or question your old knowledge about classroom assessment? (Epistemic doubt)

2. How did knowledge about CATs affect your emotions about classroom assessment? (Affect)

3. Describe the choices you considered when learning about CATs? (Epistemic volition)

4. Describe the decision-making processes you used when choosing to adopt CATs? (Epistemic volition)

5. Describe how reflection on your old knowledge about classroom assessment influenced your decision-making about CATs? (Resolution strategies)

6. Describe how participation in the CATs learning experience influenced your decision-making about CATs? (Resolution strategies)

7. Describe the changes you made to your old classroom assessment methods through accommodation (replacing your existing classroom assessment methods with a CAT) or assimilation (modifying a CAT to fit your existing classroom assessment methods?) (Resolution strategies)

8. How did working in collaborative groups influence the new knowledge about CATs and your decision to adopt CATs? (Reciprocal causation)

9. How did change in your group member’s knowledge influence your learning about CATs? (Reciprocal causation)

10. How did the workshop series change the sophistication of your beliefs about assessment? (Metacognition)

The processes used to analyze each of the question responses was to examine coded segments in an interactive quote matrix by focus group comparison. Figure 10 provides a simplistic example
of a comparative quote matrix I used for assigning comparison notes and then developing summary themes. For focused inquiry, I could isolate coded segments for non-completers from completers to determine whether there were any similarities across these participants in both series. This query also provided information about overlapping codes to understand relationships between codes.

Figure 10. Comparative Quote Matrix Example

<table>
<thead>
<tr>
<th>Focus Group 1 (1 Document, 33 Coded Segments)</th>
<th>Focus Group 2 (1 Document, 23 Coded Segments)</th>
<th>Focus Group 3 (1 Document, 12 Coded Segments)</th>
<th>Focus Group 4 (1 Document, 10 Coded Segments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I learned that students could pass all their quizzes in my course, fail the final exam and still pass the course. I was trying to be lenient with points because students typically bomb my final. So now I look at everything twice over and spent almost all of last summer revising the point totals for my courses. I even tested out scenarios based on past student performance to make sure that students really had to earn a grade to pass my courses.</td>
<td>I viewed assessment, and I still do, as a method to help students learn versus just a tool to assess or measure learning.</td>
<td>I think prior to the workshop... I don’t think I knew what the full spectrum of assessment was (2 agree) after the workshop I wanted more information, wanted to sign up for a course specifically on rubrics.</td>
<td>Ok, I think I would say that the workshops have increased the sophistication of my beliefs by allowing me to be more receptive to new ideas.</td>
</tr>
<tr>
<td>3 - 18 (10) Epistemic Beliefs</td>
<td>6 - 10 (10) Epistemic Beliefs</td>
<td>3 - 10 (10) Epistemic Beliefs</td>
<td>76 - 76 (10) Epistemic Beliefs</td>
</tr>
<tr>
<td>For me I’ve only been here a year and a half and so I have limited knowledge of student assessment especially since I come from the technology world. I give tests because that’s expected in college.</td>
<td>I had a more formal knowledge of assessment since my background is in education. I was used to standardized tests so the workshop on CATs presented assessment of student learning as more informal and simple. Actual activities and observations of learning rather than valid and reliable standardized instruments.</td>
<td>Prior to the workshop I had no knowledge of CATs and very little diversity in my assessments so I really didn’t have prior knowledge to conflict with new knowledge. My old ways of assessment were pretty limited.</td>
<td>For me I didn’t know the difference between student learning outcomes and course objectives. In my syllabus I list course outcomes as course objectives. I thought they were the same and people just called them what they preferred. I think my understanding of terminology related to assessment has broadened and changed my old knowledge about assessment just because I use the terms more distinctly around other faculty so that I can educate and enlighten them.</td>
</tr>
<tr>
<td>14 - 14 (0) Epistemic Beliefs</td>
<td>6 - 6 (0) Epistemic Beliefs</td>
<td>6 - 6 (0) Epistemic Beliefs</td>
<td>4 - 4 (0) Epistemic Beliefs</td>
</tr>
<tr>
<td>Epistemic Beliefs: More Sophisticated</td>
<td>Epistemic Beliefs: Less Sophisticated</td>
<td>Epistemic Beliefs: Less Sophisticated</td>
<td>Epistemic Beliefs: More Sophisticated</td>
</tr>
<tr>
<td>But that’s just it, times have changed. Learning is what you observe not just what adds up on a test</td>
<td>Will I miss out on teaching curriculum because it is more difficult to grade or quantify if I use the CATs?</td>
<td>Epistemic Beliefs: More Sophisticated</td>
<td></td>
</tr>
</tbody>
</table>

**Epistemic doubt, volition, and choice.** Epistemic doubt cross-linked with 17 different codes and 25 coded discussion segments. All four epistemic belief domains coded with epistemic doubt: justification for knowing (n = 9), certainty of knowledge (n = 7), simplicity of knowledge (n = 4), and source of knowledge (n = 2). This was a common theme across all four focus groups who described epistemic doubt as confusion, lack in clarity, frustration, indecision, and considering. These descriptions were closely linked with emotions and reasoning used to evaluate knowledge for value and barriers such as time. The following segment illustrates the inter-relationship of epistemic doubt, certainty of knowledge, justification for knowing, and
complexity seen in comments provided by Gwen (spring series completer) and Denise (spring series non-completer).

Gwen: “How urgent is it to make the changes? What would happen if I didn’t? Then how feasible is this CAT and do I have the time available to implement the CAT” (Focus Group, Personal Correspondence, January 30, 2018).

Denise: “I had lots of choices; what techniques do I implement?, after curriculum mapping and finding out my curriculum wasn’t aligned with my outcomes, what aspects of my curriculum do I start with to align my curriculum? what CATs would help me align my curriculum the quickest? I had the choice to be patient or overwhelmed” (Focus Group, Personal Correspondence, January 30, 2018).

Comparing these two examples, both faculty allude to the need for managing time and time as an important variable in their decision-making. Both Gwen and Denise present consequences of possible actions to consider. Gwen also expresses reasons and justifications for moving forward including thoughts about consequence. Denise lists her choices or options and includes two connected with emotion: one emotion she could control, the other she would allow to control or affect her. Both faculty demonstrate use of sophisticated belief in how they think about their choices by first recognizing the choices they have, then thinking and reasoning to weigh advantages, benefits, and barriers.

A substantial portion of all focus group discussions centered on the pre-decision stage and what influences decisions. In fact, over one-third of coded segments (n = 783) were directly linked or interlinked with attributes of innovativeness. Participants described attributes as having features of value or non-value and while some described an attribute as positive, another described the same attribute as negative. An example of this dichotomy are the comments made by Charles (spring series non-completer) and Daniel (fall series completer) when discussing CATs and the attribute of profitability: CATs are profitable by providing a variety of resources to faculty.
Charles: “There was a lot of different things presented, too many items to choose from. I guess I mean too many everything. It was too much for me. Iterative processes, ongoing processes” (Focus Group, Personal Correspondence, January 30, 2018).

Daniel: “My old ways of assessment were pretty limited. CATs helped me to incorporate a variety of activities into my classroom that I could grade that would offer more points and offer more fairness to students” (Focus Group, Personal Correspondence, February 9, 2018).

In this scenario, a variety of resources was perceived as negative (too many choices) versus positive (increased options). Knowledge can be perceived to have many attributes. This study focuses on the attributes of innovativeness (Rogers, 2003) which were used in coding segments of compatibility (n = 222), relative advantage (n = 176 comments), complexity (n = 263), of which 117 comments were exclusively about demands on faculty time. Trialability (n = 309), the ability to work with and practice new knowledge and skills, was expressed as the most prevalent influencer. Trialability mostly influenced behavioral decisions after individuals had already made the initial mental choice of consideration (i.e., epistemic volition). In the IM-IDM model, attributes of trialability and observability would be most influential as resolution strategies and a significant component of reinforcing and sustaining decisions.

At the institution, since assessment was an emphasized initiative, some faculty felt they did not have a choice in learning about or conducting assessment and their choice was compliance. Therefore, the influence of trying and observing new knowledge and skills was essential to support greater sophistication in certainty of knowledge and justification for knowing. Greater sophistication in both these epistemic domains would support beliefs that knowledge evolution and change presents opportunities for growth, while sophisticated ability to justify knowing allows one greater capacity to manage or advocate change. Consider the following discussions of Evan, Carl, and Frank who are spring series completers. Each of the
faculty express how their choices were limited, but they relied upon more sophisticated beliefs in justification for knowing to reason for change.

Evan: “I was just given a syllabus that had outcomes that weren’t measurable but I had to find a way to teach students and to assess them accurately. I was told I could do anything with the course I just couldn’t make any changes to the outcomes. So I chose to ask why? Why couldn’t there be any changes to the outcomes? Especially if they weren’t measurable. That just seemed illogical. I asked a lot of questions until I found my answer which was it was someone else’s job to take curriculum requests to the curriculum committee and no one wanted to do it. So I decided to step up to the plate and I asked my Chair if I could submit the changes and he said yes. He even helped me with the revisions” (Focus Group, Personal Correspondence, January 30, 2018).

Carl: “So part of what I learned was that you need to start curriculum development first with the outcomes. If I didn’t have good outcomes then nothing else was going to fall into place. So since my course wasn’t based on outcomes I had to decide ‘do I need to make big changes to repair things and make things right?’ or ‘can I make little change[s] and slowly correct things?’ I’ll get back to you on that and let you know” (Focus Group, Personal Correspondence, January 30, 2018).

Frank: “For me, my department we rely upon certain questions on the final to measure outcome achievement. So I was forced to comply with something that was an established practice within the department. That created some concern and a political dynamic for me because there wasn’t much that I could change. But I wanted to accept the new concepts I was learning I just needed to figure out a way to be able to try and change the department philosophy” (Focus Group, Personal Correspondence, January 30, 2018).

Epistemic doubt, volition, and choice summary. These few coded segments illustrate the importance of recognizing that faculty are learners in various stages of receiving knowledge and making decisions about professional development offered. Therefore, these findings support teaching professional development to emphasize attributes of concepts that allow learners time to contemplate new knowledge by evaluating the relative advantage, compatibility, and complexities. Presenting attributes early in professional development allows learners to formulate their pre-decision processing while presenters can assist with addressing concerns and
issues. Two additional attributes of innovations, trialability and observability, have different properties to consider. These attributes have a different and more sophisticated role in the decision stage when applying knowledge because of an active decision.

**Participation and collaboration.** Several focus group participants commented that they knew they made a decision by acting on the decision. Their descriptions of acting include applying knowledge, participating, collaborating, and testing out, practicing, sampling, evaluating, and carrying-out. Each of these descriptors in an action verb or actionable behavior. The participants describe this behavior as having to dedicate a certain amount of rigor or effort. The cognitive processes of participation and collaboration include attributes and resolution strategies that are important for supporting and maintaining decisions so that they remain in active form. Participation requires a dedication to observe and or try the new concepts to see how they can be adapted for personal use. Collaboration requires a dedication to participate with others and contribute as well as gain. The effect of participating and collaboration is both a cognitive and physical reward as described in the following excerpts from Fred (fall series non-completer), Allen (fall series completer), Henry (spring series non-completer), and Carl (spring series completer).

Fred: “I think a lot of faculty don’t understand what assessment of student learning really entails and unfortunately they won’t likely sign up for these workshops. But if they actually participate in some of these activities they can learn through experiencing what assessment really is” (Focus Group, Personal Correspondence, February 9, 2018).

Allen: “Participating in the workshop, versus just listening to a lecture, did influence me to apply the knowledge right then and there. Giving us activities where we could apply things directly to our curriculum was good because we could see how they could work for us” (Focus Group, Personal Correspondence, February 9, 2018).

Henry: “I think participating in the workshops was critical. I was a lot more involved than if I was just sitting in a lecture. The learning was more purposeful
and I was more conscious of how everyone else around me was participating. I usually don’t participate much and just listen but this workshop really asks you to be involved. If you aren’t actively doing then you miss out on the processes” (Focus Group, Personal Correspondence, January 30, 2018).

Carl: “By participating it gave me the opportunity to hear how assessment was occurring in other areas other departments” (Focus Group, Personal Correspondence, January 30, 2018).

The description of participation in each of these scenarios shows the cognitive decision to act followed by the physical effort contributed to learning. The participants each contribute effort differently and mention a certain amount of self-expectation for their participation. When the participants discuss collaboration as a part of learning, self-expectation is expressed more strongly in a sense of accountability to others. Donna (spring series completer) describes collaboration as synergistic. In this next passage, Donna describes how she recognizes a need that she can fill and she personally gains from the exchange of information. The cognitive process of reciprocal causation is a mutual cognitive benefit described in this segment.

Donna: “I think it is inherent in teaching that when someone really "gets it" we experience a sense of joy for that person. Several of the faculty in my group really struggled with how they were going to get buy in and support from their department faculty. I feel like I helped them with this because our department has already embraced assessment and I could share how working together really was synergistic” (Focus Group, Personal Correspondence, January 30, 2018).

Although several of the focus group participants describe experiencing benefits of collaboration and the value of a collaborative learning environment, participants could not provide clear responses about recognizing processes of reciprocal causation and metacognition. Responses to questions for these areas were vague in describing synergy or mutual cognition. It could be that the respondents did not experience either of these processes and therefore would not have a response. It could also be that describing these complex cognitive processes was difficult and not included in their responses.
Qualitative strand summary. The analysis of the qualitative strand revealed several insights about the variables of epistemic beliefs, cognitive processes, innovativeness, and collaborative learning using focus group discussions. Discussions naturally segmented into two distinctions of pre-decisions and decisions. A contrast comparison for coded segments of the cognitive processes illustrated in the IM-IDM found differences by cohort series and workshop series completion. There were differences in responses between spring and fall workshop participants but these could not be attributed to any differences in workshop design or offering to the participants. Differences in responses were evident between workshop completers and non-completers. However, further comparisons need to be made. The next stage of analysis is stage two independent strand summary analysis where preliminary findings and a summation of the process for theme generation follows.

Stage Two Independent Strand Summary Analysis

The summary analysis for the independent strand uses table summary displays to list the analytical or descriptive findings from previous independent strand analyses. A synthesis of findings characterizes the study population performance by groups of the research sample (i.e., spring series completers, spring series non-completers, fall series completers, fall series non-completers). In the final segment of this stage, each of the various independent strand summaries focus into a culminating summary analysis to represent the essence of the quantitative and qualitative aspects of inquiry.

Quantitative strand summary displays. The quantitative findings synthesized and summarized are (a) adjusted mean score comparisons between the ALEBQ variables, (b) comparison of ALEBQ change score gains and Cohen ‘s $d$ effect sizes across variables, and (c)
comparison of participant performance on dependent and independent variable to associate a degree of sophistication for effects.

**Epistemic beliefs adjusted mean score comparisons.** A comparison of epistemic belief means and adjusted mean scores are displayed in Table 17. The population consisted of 87 spring participants, 70 fall participants. The number of participants that completed the workshop was 101 and 56 were workshop non-completers. The data illustrated compare performance using total scale mean scores and provides insight into the change in sophistication of beliefs for group participants as a whole. Spring participants exhibited higher mean scores and greater sophistication in their response for certainty of knowledge (CK) beliefs, and fall participants showed greater sophistication in simplicity of knowledge (SK) beliefs across participant groups. Means for source of knowledge (SoK) showed very little variance. All groups showed the highest means in Justification for knowing (JK) beliefs whereas SoK reveals the lowest mean score between groups. Generally, the effect of prior knowledge and epistemic belief about assessment of learning (as measured in the ALEBQ pre-test) shows very little change when comparing means and adjusted means. Further examination of variable effects is next.

<table>
<thead>
<tr>
<th>DV</th>
<th>Spring</th>
<th></th>
<th>Fall</th>
<th></th>
<th>Completer</th>
<th></th>
<th>Non-completer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>adjM</td>
<td>M</td>
<td>adjM</td>
<td>M</td>
<td>adjM</td>
<td>M</td>
<td>adjM</td>
</tr>
<tr>
<td>CK</td>
<td>51.21</td>
<td>51.20</td>
<td>43.30</td>
<td>43.31</td>
<td>48.62</td>
<td>48.66</td>
<td>45.98</td>
<td>45.91</td>
</tr>
<tr>
<td>SK</td>
<td>46.34</td>
<td>46.34</td>
<td>51.40</td>
<td>51.40</td>
<td>49.83</td>
<td>49.84</td>
<td>46.38</td>
<td>46.36</td>
</tr>
<tr>
<td>SoK</td>
<td>40.41</td>
<td>40.48</td>
<td>40.94</td>
<td>40.86</td>
<td>41.60</td>
<td>41.55</td>
<td>38.93</td>
<td>39.03</td>
</tr>
<tr>
<td>JK</td>
<td>60.02</td>
<td>60.00</td>
<td>57.97</td>
<td>58.01</td>
<td>61.58</td>
<td>61.59</td>
<td>54.64</td>
<td>54.63</td>
</tr>
</tbody>
</table>

Notes. DV = dependent variable ALEBQ. CK = certainty of knowledge. SK = simplicity of knowledge. SoK = source of knowledge. JK = justification for knowing.

**Variable effects.** Table 18 summarizes the mean change score gains by series of participation and workshop completion groups using a mean performance score. Cohen’s $d$ effects (Cohen, 1988) were calculated for each epistemic belief domain. Cohen’s $d$ effects are equated with epistemic belief change where positive effect indicates an increase in sophistication.
of the epistemic belief and negative effect indicates a decrease in sophistication of epistemic belief. The differentiation of effect sizes are displayed by the series of workshop participation and workshop completion.

<table>
<thead>
<tr>
<th>Series</th>
<th>Workshop Completion</th>
<th>Epistemic Beliefs</th>
<th>N</th>
<th>adjM</th>
<th>∆Score</th>
<th>∆ Score M</th>
<th>SD pooled</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Non-completer</td>
<td>Pre CK</td>
<td>36</td>
<td>35.31</td>
<td>7.985</td>
<td>7.45</td>
<td>12.92</td>
<td>1.73</td>
</tr>
<tr>
<td></td>
<td>Post CK</td>
<td>36</td>
<td>48.22</td>
<td>6.912</td>
<td>6.45</td>
<td>7.39</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre SK</td>
<td>36</td>
<td>37.08</td>
<td>7.093</td>
<td>5.78</td>
<td>5.53</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post SK</td>
<td>36</td>
<td>44.47</td>
<td>5.814</td>
<td>5.76</td>
<td>6.49</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre SoK</td>
<td>36</td>
<td>33.11</td>
<td>5.646</td>
<td>5.78</td>
<td>6.49</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post SoK</td>
<td>36</td>
<td>38.64</td>
<td>5.924</td>
<td>5.78</td>
<td>6.49</td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre JK</td>
<td>36</td>
<td>51.19</td>
<td>8.444</td>
<td>8.25</td>
<td>4.58</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post JK</td>
<td>36</td>
<td>55.78</td>
<td>8.050</td>
<td>8.25</td>
<td>4.58</td>
<td>0.56</td>
<td></td>
</tr>
</tbody>
</table>

|          | Complete            | Pre CK            | 51  | 32.14 | 9.093  | 7.13       | 21.18     | 2.97      |
|          | Post CK             | 51                | 53.31 | 5.171 | 5.78   | 13.7       | 2.40      |
|          | Pre SK              | 51                | 35.04 | 5.710 | 5.72   | 13.7       | 2.40      |
|          | Post SK             | 51                | 47.67 | 4.719 | 5.72   | 13.7       | 2.40      |
|          | Pre SoK             | 51                | 35.18 | 6.352 | 5.11   | 4.15       | 0.81      |
|          | Post SoK            | 51                | 41.67 | 5.160 | 5.11   | 4.15       | 0.81      |
|          | Pre JK              | 51                | 52.31 | 6.984 | 6.92   | 10.71      | 1.55      |
|          | Post JK             | 51                | 63.02 | 6.854 | 6.92   | 10.71      | 1.55      |

|          | Non-completer       | Pre CK            | 20  | 30.25 | 7.799  | 7.61       | 11.7      | 1.54      |
|          | Post CK             | 20                | 41.95 | 7.416 | 5.72   | 13.7       | 2.40      |
|          | Pre SK              | 20                | 36.10 | 5.955 | 5.72   | 13.7       | 2.40      |
|          | Post SK             | 20                | 49.80 | 5.483 | 5.72   | 13.7       | 2.40      |
|          | Pre SoK             | 20                | 35.30 | 4.747 | 5.11   | 4.15       | 0.81      |
|          | Post SoK            | 20                | 39.45 | 5.472 | 5.11   | 4.15       | 0.81      |
|          | Pre JK              | 20                | 53.65 | 5.412 | 6.87   | 1.05       | -0.15     |
|          | Post JK             | 20                | 52.60 | 8.331 | 6.87   | 1.05       | -0.15     |

|          | Complete            | Pre CK            | 50  | 31.68 | 10.177 | 9.05       | 12.16     | 1.34      |
|          | Post CK             | 50                | 43.84 | 7.914 | 5.78   | 15.92      | 2.75      |
|          | Pre SK              | 50                | 36.12 | 7.136 | 5.78   | 15.92      | 2.75      |
|          | Post SK             | 50                | 52.04 | 4.431 | 6.46   | 5.98       | 0.93      |
|          | Pre SoK             | 50                | 35.56 | 7.077 | 6.46   | 5.98       | 0.93      |
|          | Post SoK            | 50                | 41.54 | 5.849 | 6.46   | 5.98       | 0.93      |
|          | Pre JK              | 50                | 52.12 | 8.875 | 8.17   | 8.00       | 0.98      |
|          | Post JK             | 50                | 60.12 | 7.466 | 8.17   | 8.00       | 0.98      |

Notes. adjM = adjusted mean. ∆ Score = change score. ∆ M = change score mean. SD pooled = standard deviation pooled. CK = certainty of knowledge. SK = simplicity of knowledge. SoK = source of knowledge. JK = justification for knowing.
Overall, the study population experienced moderate to large effects of change in epistemic beliefs. The greatest effects occurred in the domain of certainty of knowledge \( (d = 2.97) \) and simplicity of knowledge \( (d = 2.75) \), and lowest effect of change in the domain of justification for knowing \( (d = .56) \). The fall series non-completers showed a small decrease in sophistication of justification for knowing \( (JK) \) beliefs occurred as well \( (d = -.15) \). All groups in the study population experienced large effects of epistemic change above 1.0 in certainty of knowledge \( (CK) \), and simplicity of knowledge \( (SK) \). This suggests that after participating in the workshop and learning about CATs, spring and fall participants gained greater certainty in the evolution of classroom assessment practices in higher education, and greater confirmation that classroom assessment should involve an integration of teaching strategies, learning activities, and measures of achievement. Comparing participation by series, large effects of change were evident with spring series participants in all domains with the exception of JK in non-completers. Fall series participants experienced a lesser degree of change \( (\text{average } \Delta = 1.33) \) compared to spring participants \( (\text{average } \Delta = 1.56) \). Source of knowledge showed the least effects and least variance across groups, whereas JK manifested the greatest variance in effects. It appears that spring completers experienced the greatest effect of sophistication of beliefs and fall non-completers experienced the least gain in sophistication of beliefs.

**Sophistication of beliefs.** To summarize quantitative findings across all variables, I assigned a degree of sophistication with the level of item response on the Likert scale of \( (1) = \text{strongly disagree} \) and \( (10) = \text{strongly agree} \). For comparison purposes I interpreted of mean scale score of 7.50 to 10 as indicating a level of most sophisticated beliefs \(+S\)\), mean score of 5.00 to 7.49 indicating sophisticated beliefs \(S\), mean score of 2.5 to 4.99 indicating less sophisticated
beliefs (LS), and mean score of 0.01 to 2.49 indicating least sophisticated beliefs (-LS). Negative means indicate no gain in sophistication of beliefs (N).

In addition to determining levels of sophistication for ALEBQ responses, the mean item response for subscales of the AIS and CLQ were reviewed and the means evaluated to determine a level of sophistication. For each subscale of the AIS, participants exhibited a level of (+S) most sophistication with the exception of fall non-completers exhibiting only (S), sophistication of SoK epistemic beliefs. Perceptions of collaborative learning subscales, measured with the CLQ, show spring completer responses as (S) sophisticated, but fall non-completers showed (+S) the most sophistication in responses.

The evidence indicates that the study population predominantly shows the highest levels of sophistication in their responses. Since the AIS and CLQ were administered at the end of the workshop series, the increased sophistication across all scale items is encouraging. However, a baseline response for determining gains on the AIS and CLQ was not conducted. In addition, since item response was predominantly high in sophistication, a more definitive measure of associating sophistication of epistemic beliefs should be investigated. This gap in measuring change effects of the independent variables is limiting. However further studies could focus on measuring effects rather than perceptions of the independent variables innovativeness and collaborative learning.

It appears the study population showed an increase in sophistication of beliefs across all variable items with few exceptions (see Table 19). Mean score for each epistemic domain provides an overall picture of the degree of sophistication in epistemic beliefs for the study population. Considering that the study population are educators responsible for imparting knowledge to learners, I was not surprised to find that item response scores cluster in the upper
range of the 10-point Likert scale. Overall, the workshop participants all demonstrated or expressed sophisticated or more sophisticated beliefs in their decision-making about CATs. An exception is fall series completers that show a rating of less sophistication in justification for knowing beliefs. To confirm the JK anomaly, I conducted a secondary screening of the data to assure that no data transfer or cleaning errors were present. No additional faculty demographics were available with the acquired datasets from the institution that could be used to examine the variation in item response scores. Additional extraneous variables such as faculty teaching discipline, time teaching in higher education, or degree of academic freedom within a department could be additional extraneous variables that have an influence on pre-test knowledge that were not examined in this study.

Spring workshop participants exhibited the most sophistication in epistemic beliefs between workshop series cohorts. Across both faculty cohorts, the faculty shared similar ranges of most sophisticated beliefs about the innovativeness of CATs with the exception of fall non-completers who exhibited only sophisticated beliefs about the attribute of complexity being relevant to innovativeness.

Spring completers who manifested the most sophisticated beliefs in almost all variables had a lower mean in simplicity of knowledge (indicating less belief in knowledge as integrated and complex) and lower means of sophisticated beliefs for both individual and group development of the collaborative learning strategy employed in the professional development workshop series. This finding is of interest considering the spring completers had the highest scores in the study population for certainty of knowledge and justification for knowing. Both these epistemic belief domains share a unique understanding that knowledge is not passive and that one must be involved in learning and knowing while knowledge is created when interacting
with others. However, both groups in the spring cohort had lower mean scores than the fall cohort. This may indicate the two cohorts experienced collaborative learning differently or another unaccounted for variable was present at the second workshop.

A summarization of findings through comparing mean scores of all variables suggests that both cohorts (fall and spring series) generally exhibited a level of most sophisticated (+S) beliefs across most measures. Further attention could be given to the wide variance in sophistication of beliefs for the fall series completer cohort. In addition, whether a perception of CAT complexity may speak to an underlying pragmatic concern faculty have regarding limited time for assessment. Further understanding of faculty epistemic beliefs and the variable of complexity should be examined in greater detail. Different strategies of inquiry may provide a larger data set and richer data to comprehend how individuals experience collaborative learning.

The data acquired for this study did not have sufficient power to determine causal and predictive effects through structural equation modeling. The effects that could be determined occurred with two paths of CK as the outcome variable, one path as a mediator, and one path as the predictor. Although causal and mediating effects were not statistically significant, these pathways may have value and importance when considering the mixed data in this study.

Quantitative strand key findings.

1. Overall, workshop participants exhibited epistemic belief change in all four domains.

2. There was little effect of prior knowledge on increased sophistication of epistemic beliefs about assessment of learning.

3. Participants in the spring series workshop showed the largest effects of epistemic change and increased sophistication in all four epistemic belief domains
4. Fall workshop participants experienced the greatest sophistication in perceptions of innovativeness and collaborative learning.

5. Greater change in sophistication occurred with perceived innovativeness compared to perceptions of collaborative learning.

Table 19. Degree of Sophistication from Mean Scores and Cohen’s d effects

<table>
<thead>
<tr>
<th>Population</th>
<th>EB</th>
<th>adjM</th>
<th>S</th>
<th>d</th>
<th>S</th>
<th>IN</th>
<th>M</th>
<th>S</th>
<th>CL</th>
<th>M</th>
<th>S</th>
</tr>
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<tbody>
<tr>
<td>Spring</td>
<td>CK</td>
<td>9.24</td>
<td>+S</td>
<td>2.97</td>
<td>+S</td>
<td>RA</td>
<td>8.32</td>
<td>+S</td>
<td>ID</td>
<td>6.83</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>SK</td>
<td>7.76</td>
<td>+S</td>
<td>2.42</td>
<td>+S</td>
<td>C</td>
<td>8.33</td>
<td>+S</td>
<td>GD</td>
<td>6.89</td>
<td>S</td>
</tr>
<tr>
<td>Completers</td>
<td>SoK</td>
<td>8.36</td>
<td>+S</td>
<td>1.13</td>
<td>+S</td>
<td>CX</td>
<td>8.17</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>9.00</td>
<td>+S</td>
<td>1.55</td>
<td>+S</td>
<td>T</td>
<td>9.22</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+S</td>
<td>O</td>
<td>8.89</td>
<td>+S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>CK</td>
<td>7.90</td>
<td>+S</td>
<td>1.73</td>
<td>+S</td>
<td>RA</td>
<td>7.90</td>
<td>+S</td>
<td>ID</td>
<td>7.75</td>
<td>+S</td>
</tr>
<tr>
<td>Non-</td>
<td>SK</td>
<td>7.81</td>
<td>+S</td>
<td>1.15</td>
<td>+S</td>
<td>C</td>
<td>8.25</td>
<td>+S</td>
<td>GD</td>
<td>7.60</td>
<td>S</td>
</tr>
<tr>
<td>Completers</td>
<td>SoK</td>
<td>7.50</td>
<td>+S</td>
<td>.96</td>
<td>+S</td>
<td>CX</td>
<td>8.25</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>7.96</td>
<td>+S</td>
<td>.56</td>
<td>+S</td>
<td>T</td>
<td>8.82</td>
<td>+S</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+S</td>
<td>O</td>
<td>8.71</td>
<td>+S</td>
<td></td>
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</tr>
<tr>
<td>Fall</td>
<td>CK</td>
<td>8.46</td>
<td>+S</td>
<td>1.34</td>
<td>+S</td>
<td>RA</td>
<td>8.00</td>
<td>+S</td>
<td>ID</td>
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<td>S</td>
</tr>
<tr>
<td>Completers</td>
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<td>+S</td>
<td>2.75</td>
<td>+S</td>
<td>C</td>
<td>7.95</td>
<td>+S</td>
<td>GD</td>
<td>8.00</td>
<td>+S</td>
</tr>
<tr>
<td></td>
<td>SoK</td>
<td>8.31</td>
<td>+S</td>
<td>.93</td>
<td>+S</td>
<td>CX</td>
<td>8.00</td>
<td>+S</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>JK</td>
<td>4.90</td>
<td>LS</td>
<td>.98</td>
<td>+S</td>
<td>T</td>
<td>8.22</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+S</td>
<td>O</td>
<td>8.67</td>
<td>+S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td>CK</td>
<td>6.81</td>
<td>S</td>
<td>1.54</td>
<td>+S</td>
<td>RA</td>
<td>8.07</td>
<td>+S</td>
<td>ID</td>
<td>7.50</td>
<td>+S</td>
</tr>
<tr>
<td>Non-</td>
<td>SK</td>
<td>8.36</td>
<td>+S</td>
<td>2.40</td>
<td>+S</td>
<td>C</td>
<td>8.10</td>
<td>+S</td>
<td>GD</td>
<td>8.25</td>
<td>+S</td>
</tr>
<tr>
<td>Completers</td>
<td>SoK</td>
<td>7.69</td>
<td>+S</td>
<td>0.81</td>
<td>+S</td>
<td>CX</td>
<td>6.93</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>7.39</td>
<td>S</td>
<td>-.15</td>
<td>N</td>
<td>T</td>
<td>9.00</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O</td>
<td>8.71</td>
<td>+S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. EB = epistemic beliefs. adjM = adjusted mean. S = level of sophistication. d = Cohen’s d effect size.
IN = innovativeness. CL = collaborative learning. CK = certainty of knowledge. SK = simplicity of knowledge.
CX = complexity. T = trialability. O = observability. ID = individual development. GD = group development.
+S = most sophisticated. S = sophisticated. LS = less sophisticated. N = no sophistication gain.

Qualitative strand summary theme analysis. The summary theme analysis began by viewing individually coded segments of each transcript for each of four coding criteria sets (i.e., epistemic beliefs, cognitive processes, attributes of innovativeness, and collaborative learning). Magnitude coding and concept coded segments were cross-coded and summarized into paraphrased notes by focus groups. I condensed these segments into themes based on theoretical processes and most commonly used codes. This section lists the summary themes of each focus group and discusses the differences and similarities between the group findings.
Focus Group 1 - Spring Workshop Series Completers
1. Acknowledging deficiencies in prior beliefs makes it easier to accept new knowledge
2. Prior knowledge of assessment was simplistic
3. Trying and practicing helped to add clarity to a new way of believing
4. Emotions played a large role in receptiveness to new ideas
5. Choices or options are different from the reasoned action of decisions
6. Making decisions involves a new way of thinking
7. Participating in the workshop demands responsibility
8. Workshop participation involves a time commitment
9. Workshop participation helps me produce results
10. Modifying existing assignments is more compatible than replacing existing assignments with the new knowledge and skills (innovation.)
11. Collaboration was a safe testing ground to facilitate the decision process.

Focus Group 2 – Spring Workshop Series Non-completers
1. Less sophisticated epistemic beliefs were aligned with a reluctance to accept new knowledge and skills (innovation.)
2. New knowledge and skills (innovation) could be practical for teaching.
3. New knowledge and skills (innovation) could benefit others.
4. Choices (options) and decisions (reasoned action) are the same concept
5. Modifying existing assignments with the new concepts takes time and commitment.
6. Reflection is separate from decision-making.
7. Few participants perceived collaborative learning as a learning opportunity.
8. Workshop participation produces accountability and a desire to learn.
9. Few participants perceived diversity in group beliefs as beneficial.
10. Motivation benefits from group learning were not recognized.

Focus Group 3 – Fall Workshop Series Completers
1. Prior beliefs about assessment of learning can change and increase in sophistication.
2. New knowledge and skills (innovation) can increase teaching effectiveness.
3. Reasoning and justification are a part of decision-making.
4. Decisions (reasoned action) have distinct processes compared to a single choice (option).
5. Reflection can facilitate or confirm decisions.
6. Practice can reinforce and resolve decisions.
7. Participating with others is a valuable opportunity.
8. Participation is associated with commitment and effort.
9. Adding new assignments is more timely and agreeable than modifying existing assignments.
10. Participating in collaborative learning is engaging but not valuable or profitable.
11. Feedback is necessary to confirm decisions.
12. Group motivation is essential for learning.

Focus Group 4 – Fall Workshop Series Non-completers
1. Decision-making requires increased clarity.
2. Learning is gaining knowledge rather than changing beliefs.
3. Consequences require reasons for choices. Reasoning is associated with excuses.
4. Decision-making involves processes.
5. Reflection is used to rationalize or justify decisions.
6. Participation is associated with consistent attendance.
7. Few participants implemented the new knowledge and skills (innovation).
8. Few participants perceived collaborative learning as a benefit or positive experience.

<table>
<thead>
<tr>
<th>Cognitive Process</th>
<th>Theme</th>
<th>Epistemic Belief</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemic Doubt</td>
<td>Recognition of deficiencies in prior thinking</td>
<td>CK</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>Recognition that attributes fluctuate in importance, value, and desire</td>
<td>SK, CK</td>
</tr>
<tr>
<td>Epistemic Volition</td>
<td>Recognition of “cues to actions”</td>
<td>SK, JK</td>
</tr>
<tr>
<td>Decision-making</td>
<td>Differentiation of choice (selection) from decision (reasoned action) through steps and processes of weighing and considering</td>
<td>CK, JK</td>
</tr>
<tr>
<td>Emotion</td>
<td>Perceived internal source of motivation</td>
<td>SoK</td>
</tr>
<tr>
<td>Affect</td>
<td>Perceived external source of motivation</td>
<td>SoK</td>
</tr>
<tr>
<td>Resolution Strategies</td>
<td>Observation and Participation are linked to commitment, effort and time Practice and trying are linked to reinforcement and refinement of decision Collaboration is an opportunity for trying new things</td>
<td>SoK</td>
</tr>
<tr>
<td>Metacognition</td>
<td>Shift in thinking about thinking to how we know about knowing</td>
<td>SK, CK</td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>Expectation of accountability for self and others in collaborative learning</td>
<td>SoK</td>
</tr>
<tr>
<td>Reciprocal Causation</td>
<td>Synergistic effect among collaborators</td>
<td>SoK, CK</td>
</tr>
</tbody>
</table>


**Stage Three Integrated Analysis**

**Qualitizing and quantitizing data.** For integrated analysis, summary strand data were evaluated and mixed through qualitizing and quantitizing processes using interactive summary tables in MAXQDA Pro software. First, the degree of sophistication assigned to the independent and dependent variables in quantitative strand analysis was used to evaluate focus group coded segments and assign a numeric score representing the manifestation of sophistication used in cognitive processes. Magnitude codes were then used to quantitize the coded segments and then
determine a final level of sophistication and epistemic belief effect. The qualitizing and quantitizing process is described next.

**Magnitude coding.** Magnitude coding was used to correlate coded segments of qualitative data with a numeric rank indicating the degree to which specific cognitive processes and epistemic beliefs were evident in the coded discussion (0- Not clear, 1- Possible, 2 – Likely), evidence of attributes of innovativeness (0- Not clear, 1- Possible, 2 – Likely), and evidence of collaborative learning (0- Not clear, 1- Possible, 2 – Likely). Last, each quantitized segment was associated with a degree of sophistication displayed in the passage. The coding was similar to Likert-type scales: ALEBQ (0 – less sophisticated, 5 – unclear, 10 – more sophisticated). Figure 11 provides an example of magnitude coding for determining the level of sophistication for simplicity of knowledge.

After quantitizing and qualitizing, the associated weighted points were totaled for each coding element indicated in Table 21. Totals were differentiated by focus group series and completion status. The integrated findings suggest fairly equal sums for spring and fall completers and fairly equal sums for spring and fall non-completers, but there are large variations in scores for individual components. This suggests that there may be common, cognitive processes that are more collectively similar for completers and non-completers even though they consider items and issues differently. Higher scores can be equated with higher levels of sophistication and certain processes may require more levels of effort that reflect higher scores. The interpretation of these scores as degrees of sophistication and levels of effort need further thought and analysis. The next stage of pattern analysis can add a visual element and provide greater meaning for interpretation of these findings.
Figure 11. Magnitude Coding for Sophistication of Epistemic Beliefs

Table 21. Quantitized Coded Segments through Weight Coding

<table>
<thead>
<tr>
<th>Weighted Code Variables</th>
<th>Spring Completers</th>
<th>Spring Non-completers</th>
<th>Fall Completers</th>
<th>Fall Non-completers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplicity of Knowledge</td>
<td>10.16</td>
<td>9.38</td>
<td>16.41</td>
<td>14.06</td>
</tr>
<tr>
<td>Source of Knowledge</td>
<td>19.32</td>
<td>9.09</td>
<td>12.50</td>
<td>9.09</td>
</tr>
<tr>
<td>Justification for</td>
<td>15.63</td>
<td>4.58</td>
<td>15.10</td>
<td>4.69</td>
</tr>
<tr>
<td>Knowing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certainty of Knowledge</td>
<td>16.67</td>
<td>10.83</td>
<td>10.00</td>
<td>12.50</td>
</tr>
<tr>
<td>Epistemic Doubt</td>
<td>12.50</td>
<td>12.50</td>
<td>18.75</td>
<td>6.25</td>
</tr>
<tr>
<td>Epistemic volition</td>
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<td>0.00</td>
<td>18.50</td>
<td>18.75</td>
</tr>
<tr>
<td>Affect</td>
<td>16.46</td>
<td>14.58</td>
<td>15.63</td>
<td>8.33</td>
</tr>
<tr>
<td>Resolution Strategies</td>
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<td>10.50</td>
</tr>
<tr>
<td>Reciprocal Causation</td>
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<td>7.41</td>
<td>25.93</td>
<td>5.56</td>
</tr>
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<td>Metacognition</td>
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<td>13.20</td>
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</tr>
<tr>
<td>Observability</td>
<td>25.00</td>
<td>4.70</td>
<td>10.90</td>
<td>9.40</td>
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<tr>
<td>Compatibility</td>
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<td>5.80</td>
<td>20.80</td>
<td>5.00</td>
</tr>
<tr>
<td>Relative Advantage</td>
<td>18.10</td>
<td>11.70</td>
<td>13.80</td>
<td>6.40</td>
</tr>
<tr>
<td>Trialability</td>
<td>8.20</td>
<td>18.50</td>
<td>13.00</td>
<td>10.30</td>
</tr>
<tr>
<td>Complexity</td>
<td>15.80</td>
<td>4.10</td>
<td>18.50</td>
<td>11.60</td>
</tr>
<tr>
<td>Total Score</td>
<td>257.49</td>
<td>142.19</td>
<td>252.06</td>
<td>143.37</td>
</tr>
</tbody>
</table>
Stage Four Pattern Analysis

After stage three, an initial evaluation of the data allowed categorization into common clusters that appeared to have related or supporting structures. Next, I selected a pattern type that had the capacity to display data in a linear pattern similar to the original IM-IDM theoretical construct model. Then, a preliminary pattern design was determined that allowed for factor overlays and ability to relate the three main variables in this study epistemic beliefs, attributes of innovativeness, and collaborative learning. The following describes how the pattern map was developed and the analysis formed to support interpretation and inferences in stage five.

IM-IDM framework base. I reviewed the original IM-IDM framework for its essential cognitive components, process flow, and interpretive structure (see Figure 2). Working with the MAXQDA PRO program, I selected a mapping model that represented a linear flow similar to the original model from the point of current epistemic beliefs through the mechanism of change to the outcome of advanced (sophisticated) epistemic beliefs. I also wanted a vertical element to allow for non-linear processes occurring above and below a median that differentiates motivating influences to potentiate movement towards change. Qualitized variable effects determined from the mixed methods analysis (i.e., small, medium, and large) appear in line thickness and size of the variable symbol. Location of the dependent and independent variables indicate their presence and influence in the timeline of decision-making. Positions of some IM-IDM components have changed from the original model based on the findings of this study. A description of the maps, elements, and overlays follow.

Epistemic beliefs. In the original IM-IDM, the linear element starts with epistemic beliefs on the left as the dependent variable for observed change. The next element in the linear sequence is conditions for change that would accommodate the influence of independent
variables. Epistemic beliefs are represented generally and subcomponents of each epistemic belief domain are not listed in the model. Conditions for change are not specified but indicate the influence of independent variables or extraneous variables in the change process. In the IM-IDM proposed in this study, the cognitive processes of epistemic doubt, epistemic volition, resolution strategies, metacognition, affect, and reciprocal causation cluster in the middle of the model and are displayed as the base pattern map shown in Figure 12. Last, the independent variables of this study, innovativeness (attributes of innovations) and collaborative learning are integrated in the pattern map at points where they were observed to influence decisions or affect epistemic beliefs of the research sample in this study.

Figure 12. Pattern Map of Cognitive Processes in Decision-making

**Pre-decision and decision stage.** Study findings differentiate two primary focal points for the pattern base. Focus one is a stage of pre-decision that begins from epistemic doubt through epistemic volition to the point when a choice is cognitively determined, but not acted
upon by any behavior. Focus two represents the decision stage from when a decision is actioned by motivated behavior and then is supported and sustained through continued effort towards change. Clear outlined arrow components above the median represent mental processes intrinsic to decision making: affect, epistemic volition, metacognition. Solid color components below the median represent cognitive components that can be extrinsic to the decision process and require behavior or effort to potentiate change and more sophistication in epistemic beliefs.

Epistemic beliefs. The first overlay in Figure 13 shows the four dependent outcome variables of epistemic beliefs. This overlay illustrates the dynamic relationship of epistemic beliefs that account for interconnected in purpose, but also distinct differences in effect. In the research population, simplicity of knowledge (SK) manifested early in the decision-making process as one contemplates the scope of knowledge in depth and breadth of detail and complexity. Therefore, SK was positioned in the upper left quadrant of pre-decision when self-questioning thoughts about what knowledge is was most predominant. Shortly thereafter in the process, certainty of knowledge (CK) presented in decision-making as one contemplates how knowledge changes and the relevancy that changing knowledge has in one’s life. In this study, CK was a constant variable evident from early contemplation through reinforcement of decisions in collaborative learning. The line connects from the upper left quadrant and spans across the map to the upper right quadrant depicting an influence of constancy in decision-making.

Justification for knowing (JK) also manifested in pre-decisions as one thinks about why one considers new knowledge and what actions they should take based on the new knowledge. JK spans from the upper left quadrant to the lower left quadrant acknowledging that reasoning and justifications result from both intrinsic motivation (above the median) and extrinsic
motivation (below the median). Justification for knowing manifested as mental activities of decision-making and was influenced by the new knowledge attributes of innovativeness.

Source of knowledge manifested early in the pre-decision phase also, but to a lesser degree than SK or CK. The presence of SoK in decision-making primarily manifested after decisions were made and influenced expectations and interaction in collaborative learning. In the lower right quadrant, collaborative activities are a source of knowledge through interaction with others. This is likely to occur during collaboration and reciprocal causation. Explanation of the role of each epistemic belief and significance of its position occurs in the interpretation.

Figure 13. Pattern Map of Cognitive Processes and Integration of Epistemic Beliefs

Innovativeness and collaborative learning. The last overlay includes the two independent variables in this study: innovativeness and collaborative learning (see Figure 14). Innovativeness has five attributes of relative advantage, compatibility, complexity, trialability, and observability. The positioning of each attribute indicates where in the timeline of decision-making they most frequently manifested or appeared to influence decisions. Collaborative learning appeared as a singular attribute that reinforced decisions through the influence of other’s
understanding and support. Of the five attributes of innovativeness, three commonly manifested through integrated analysis in the pre-decision phase. Compatibility, complexity, and relative advantage were most associated with epistemic doubt, whereas the attributes of observability and trialability extend from pre-decision stage to facilitate the decision stage. The interpretation of pattern map components based on the findings of this study is next and provides a culminating perspective of innovative decision-making.

Figure 14. Pattern Map of the Integrated Model of Innovation Decision-Making

Stage Five Interpretation and Inferences

Pattern mapping helped to visualize the relationship of the study variables in comparison to the hypothesized IM-IDM model. When implemented, certain model elements manifested differently such as (a) an un-expected linear action to the decision-making process, and (b) overlapping roles of epistemic beliefs in relationship to variables and subcomponents. This section provides an interpretation of the findings in this study as displayed in the pattern analysis
map. The interpretation includes an explanation of the study variables, key findings, pragmatic use of findings, and culminates in three key inferences.

**Disequilibration.** Individuals, when asked to consider new knowledge about assessment, first contemplate what their existing knowledge about assessment is and how it may be different from the new knowledge they may learn. Even before they have been exposed to the new knowledge or skills, the suggestion that knowledge has somehow changed (for better or worse), is perceived by most individuals in this study as an imbalance that needs balancing. Hofer and Pintrich (1997) describe disequilibration as a state when new knowledge does not coincide with old knowledge. Therefore, learners apply a process of questioning or confirming their existing knowledge (Hofer & Pintrich, 1997). The patterns I observed in this study support Olitsky’s (2015) description of cognitive dissonance as a wavering process in accepting or rejecting new knowledge in part or in whole. Where Bendixen and Rule (2004) describe disequilibration and cognitive dissonance as a process of contemplating and rejecting new knowledge to develop personal epistemology and in deciding or returning to prior epistemic beliefs, this process is illustrated in the IM as a forward or backward linear motion. Findings in this study suggest a different flow process of cognitive dissonance and disequilibration.

**Weighing effect.** In this study, once faculty were exposed to new knowledge, cognitive dissonance occurred by weighing attributes in polarized contexts of positive and negative aspects of the attribute. However, these were not acceptance and rejection of the attributes, as was hypothesized by Bendixen and Rule (2004). Instead, in this study, it was apparent that the dissonance action was more of a neutral holding pattern where refinement in understanding occurs. This continued motion without a forward action appears to be a perpendicular weighing motion that crosses the median line. Furthermore, if an individual rejected new knowledge after
a short term of cognitive dissonance, rejection of the new knowledge does not erase the presence of the knowledge in a backward effect of returning to a prior state of beliefs described and illustrated in the IM (Bendixen & Rule, 2004). Knowledge not previously acted upon after experiencing cognitive dissonance could be in a neutral pattern of contemplation or a continuing state of refinement in understanding. For example, with spring workshop participants, several who rejected CATs and did not complete the workshop series did not implement any of the workshop activities, actually re-registered for the fall workshop series and were very motivated to implement the workshop requirements at a different time and place. It would appear that the spring workshop series non-completers processed the new knowledge but did not follow through with the effort needed to change their decision to adopt a new way of completing assessment of learning. This new knowledge did not go away, it was active but not perpetuated forward as useful until a time and place (next fall) whereas fall participants were more receptive to applying more effort to the learned knowledge by participating in the workshops, trying the concepts in the activities, and eventually adopting the new knowledge and skills.

**Decision-making process and flow.** The first interpretation gleaned from the pattern analysis is a suggested modification of the IM-IDM flow process. Instead of a linear vacillating back and forth between the mechanism of action (i.e., epistemic doubt, epistemic volition, resolution strategies), I perceived a process of upward and downward weighing that is wave-like. I perceived the weighing as an action process of justification for knowing beliefs. The first evidence of this was the early manifestation and overlapping of five variables (simplicity of knowing, justification for knowing, attributes of innovation, epistemic doubt, and epistemic volition) in almost 60% of the integrated data. The motion of considering the simplicity of the attributes of compatibility versus complexity versus relative advantage that comes through using
sophisticated reasoning and justification for knowing the new knowledge simulates a wave-like action. During this reasoning and justification wave-like process, the participants in this study formulated and considered choices or *what if* scenarios, where they weighed advantages and disadvantages, and benefits to barriers. In comparison, more non-completers expressed oppositional choices whereas more completers expressed a singular choice with a reason for pursuing the choice when they recalled their epistemic doubt. For this visualized process, the reasoning and justification process of upward and downward weighing motion of contemplating new knowledge or newly reconsidered knowledge continued until some combination of the attributes of the innovation came into balance and became an action potential.

Epistemic volition, what participants expressed as key points or cues, helped them focus on a choice and activate mental processes to come to a decision. The most prevalent cue to action for participants in this study was personal emotion or some external affect such as Beth’s comment that she was only interested in the CAT innovation because she was pre-tenure and the workshop would look good on her tenure application. Although several other participants expressed reasons for attending the workshop to learn that were extrinsically motivated, the data shows motivated participants had an intrinsic desire to improve their teaching and improve student learning. The most prevalent barrier expressed was faculty concern about the amount of time they needed to dedicate to learning, creating, and implementing the innovation of CATs in their classes. Furthermore, almost all non-completers expressed the negative attribute of time constraint as their primary reason for discontinuing the workshop series and rejecting the innovation of CATs. In contrast, completers found a cue or cues to action such as desire for improved teaching and compatibility with personal values that out-weighed the barrier of time-constraint. Cues to action not only require individual action to make a decision, but also propel
one from the pre-decision to the decision stage. Cues to action appear to prompt a physical as well as mental dedication to act on the decision made. Physical behavior of participation requires effort to support and sustain decisions through resolution strategies: acts of observing and emulating others’ behavior, trying the knowledge and skills.

Certainty of knowledge was found as a constant variable that appeared in almost all integrated themes and had the potential to be a significant outcome variable in two mediated pathways of structural equation modeling. The presence of certainty in both pre-decision and decision stages suggests this domain may function in a confirming capacity of changing knowledge. In pre-decision as one recognizes that knowledge can change or there is a need for knowledge to change (certainty of knowledge), attributes of innovativeness were interlinked with epistemic doubt. In the decision stage, certainty of knowledge was interlinked with metacognition and personal reflection. Further, both certainty of knowledge and source of knowledge were interlinked with collaboration or collaborative learning.

The cognitive processes of the decision stage below the median line of the IM-IDM require physical effort or behavior that allow an individual to experience the new knowledge in its applied form. Although some workshop non-completers did complete some of the workshop activities, few adopted CATs in their courses. In contrast, almost all workshop completers implemented most of the activities and most completers adopted the CATs they created in the workshops. Participants contributed effort towards their decisions by applying their new knowledge, and some participants were able to recognize complex cognitive processes illustrated above the median line in the decision stage. In this study, reflection facilitated reinforcement of decisions for an individual learner. In this study, individuals with more sophisticated beliefs in certainty of knowledge used reflection to confirm their decisions. Individuals who contributed to
collaborative learning expressed knowing that they had gained a reciprocal effect from their peers that supported their decision to adopt CATs. The integrated findings also suggest that for both workshop series, those that committed to their collaborative learning groups benefit from greater sophistication of epistemic beliefs and are likely to complete intended outcomes.

**Collective Portrait**

In this study, workshop participants increased in sophistication of epistemic beliefs primarily in simplicity and certainty of knowledge, and to a lesser degree in source and justification for knowing. Action cues of emotion were predominant for many of the workshop participants in making a decision about accepting the innovation of CATs and continuing to participate in the workshop series. Workshop completers were more likely to adopt the innovation of CATs compared to non-completers. Participants with greater sophistication in source of knowledge beliefs found the collaborating learning experience to be positive and beneficial. In addition, completers expressed more interest than non-completers did in seeking knowledge from peers and valuing expert guidance. More importantly, completers within the research sample expressed adoption of the innovation CATs had improved their teaching ability and they felt they had more sophisticated ways of determining and evaluating valuable assessment measures for their courses. In addition to these essential insights, the collective portrait of workshop participant degree of sophistication is compared and contrasted between completers and non-completers (see Table 22); and between spring and fall participants (see Table 23).
Table 22. Workshop Participant Sophistication by Completion Status

<table>
<thead>
<tr>
<th>Cognitive Processes</th>
<th>Epistemic Domain</th>
<th>Completers</th>
<th>Non-completers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemic Doubt</td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>SK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Epistemic volition</td>
<td>SK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td>Decision-making</td>
<td>CK</td>
<td>+ sophistication</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td>Emotion</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Affect</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Resolution Strategies</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td>Metacognition</td>
<td>SK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Reciprocal Causation</td>
<td>Sok</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>Neutral</td>
<td>- sophistication</td>
</tr>
</tbody>
</table>

Notes. CK = certainty of knowledge. SK = simplicity of knowledge. SoK = source of knowledge. JK = justification for knowing. + = increased. - = less.

Table 23. Workshop Participant Sophistication by Series of Completion

<table>
<thead>
<tr>
<th>Cognitive Processes</th>
<th>Epistemic Domain</th>
<th>Spring series</th>
<th>Fall series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemic Doubt</td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>SK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Epistemic volition</td>
<td>SK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td></td>
<td>JK</td>
<td>+ sophistication</td>
<td>- sophistication</td>
</tr>
<tr>
<td>Decision-making</td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Emotion</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Affect</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Resolution Strategies</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Metacognition</td>
<td>SK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Collaborative Learning</td>
<td>SoK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td>Reciprocal Causation</td>
<td>Sok</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
<tr>
<td></td>
<td>CK</td>
<td>+ sophistication</td>
<td>+ sophistication</td>
</tr>
</tbody>
</table>

Notes. CK = certainty of knowledge. SK = simplicity of knowledge. SoK = source of knowledge. JK = justification for knowing. + = increased. - = less.

Summary

New knowledge about assessment of learning was found to be additive with existing knowledge and perceived to be innovative. Findings in this study suggest when new knowledge
is rejected understanding of the new knowledge is not eliminated. Perceived value of new knowledge occurred through weighing attributes of innovativeness. Thus, professional development leaders should focus on providing curriculum content and teaching strategies that have varied attributes, and have the greatest potential to connect with faculty who are experiencing cognitive dissonance. If faculty development leaders take a pragmatic approach of combining understanding of epistemic beliefs change and innovative decision-making with their planning processes, there is the potential for more outcome variable to be achieved.
CHAPTER 5: DISCUSSION AND MEANING

Introduction

This chapter presents a discussion of the implications of the results presented in Chapter Four. First, I discuss the main findings of the mixed methods analysis and possible explanations of variable relationships related to the IM-IDM model and pattern analysis. Next, I emphasize key contrasts and comparisons in the integrated analysis, then discuss inferences drawn from the findings. Last, the inferences are connected to the theoretical components of this study to determine any implications. A review of limitations and suggestions for future directions in research precede conclusions and summary of this study.

Discussion of Findings

The main findings of the study include:

(a) Workshop participants had statistically significant increases in sophistication of epistemic beliefs after experiencing professional development.

(b) A new action of cognitive processing in decision-making is suggested to explain how choices are considered and weighed before potentiated to decisions.

(c) Innovativeness, collaborative learning and epistemic beliefs appear to influence cognitive processes of decision-making through reasoning and justification.

Research Expectations

For this study, it was expected that most faculty would:

1. Demonstrate an increase in sophisticated epistemic beliefs about assessment of learning because of the innovative professional development workshop strategy.

2. Differentiate and express cognitive processes occurring during innovation decision-making.
Response to Research Expectations.

Response one. In this study statistically significant increases in sophistication for all four epistemic belief domains (i.e., certainty of knowledge, simplicity of knowledge, source of knowledge, and justification for knowledge) were found when faculty were asked about the innovative attributes of classroom assessment techniques, and collaborative learning as professional development learning strategies. There are four main considerations related to increases in sophistication of epistemic beliefs related to participation in the professional development workshop.

1. Participants in this study generally exhibited existing sophistication of beliefs across all domains. However, increased sophistication of epistemic beliefs was found in workshop completers but not workshop non-completers.

2. Workshop completers who had the greatest increases in sophistication of epistemic beliefs may not have had favorable experiences with collaborative learning, but they were more apt to engage in collaborative learning than other workshop participants were.

3. Workshop non-completers who had the greatest increases in sophistication of epistemic beliefs recognized greater complexity with innovation than the rest of the workshop participant groups.

4. Although statistically significant increases in sophistication of epistemic beliefs occurred in all four domains after workshop completion, causal and mediating effects of the workshop variables on epistemic beliefs could not be determined.

These findings suggest that the workshop curriculum and its measures were able to produce and determine increases in sophistication of epistemic beliefs for the participants as the institution intended in their workshop design. In addition, the measures to associate
innovativeness and collaborative learning appear to be adequate but could be improved. Poor correlation among independent and dependent variables indicate better instrument design and quality.

Response two. Most faculty were able to express and explain the various cognitive processes occurring in their decision-making. However, most could not differentiate between the cognitive processes to self-identify the best ways to inform themselves prior to decision-making. It appears that faculty have concerns about not having availability to new knowledge and the opportunity to know what new information is available to them. The findings related to cognitive processing of epistemic doubt, epistemic volition, and decision-making acknowledge faculty desire and need for new choices in knowledge, and to be given a broad scope of the purpose, value, and complexities in the learning process so that they can use greater sophistication in their reasoning and justifications to make decisions.

Relationship of Results to Theory

The results of the study have theoretical implications for understanding cognitive aspects of epistemic change theory and social change theories such as diffusion of innovations (Rogers, 2003). The following section presents a discussion in reference to possible ways the current study clarifies and extends the theoretical understanding of mechanisms of change related to cognitive functions and epistemology. More important, there is relevance of promoting a more distinct causal mechanism of epistemic change within social change as a distinct theoretical model for future research. The relevance of having a distinct theoretical model is to promote greater effort of research in an area that has such pragmatic value and need in higher education.

One of the theoretical goals of this study was to explore whether the cognitive constructs identified in the IM model proposed by Bendixen and Rule (2004) could be manifest under
conditions of a small-scale phenomenological inquiry and compared to quantitative results to strengthen the hypothetical model. Although limited in design, the current study was able to achieve greater clarity of the IM through implementation of the theoretical model in this study that integrates attributes of innovation (i.e., relative advantage, compatibility, complexity, trialability, and observability) as key influencers during a pre-decision stage. This pre-decision stage is compared to the persuasion stage illustrated by Rogers (2003). However, I submit that pre-decisions are distinct mental processes of weighing that is suggested in Rogers (2003) condition of self-persuading. Pre-decision is a less active state when weighing choices until the influence of an attribute potentiates a cue to act (epistemic volition) on a decision. However, there is still much research needed to understand how these mechanisms of change occur within various populations.

Implications for Practice and Future Research

Findings from this research have a pragmatic purpose for the college research site. However, results may be used for improvement in faculty development design at other colleges. In this study, spring completers found that collaborative learning that allows for trying and practicing with new concepts helped to add clarity to a new way of thinking about classroom assessment. Colleges need to consider whether (a) current delivery of faculty development is causing behavior change in teaching practices by implementing regular assessment measures, (b) trying and participating activities should be included in faculty development offerings to assure that participants can transfer knowledge to skills they can implement in their teaching practice, (c) Faculty development should include peer collaboration as a mechanism to influence and reinforce decisions about new knowledge since peers appear to be predominate sources of knowledge that faculty prefer.
This study design can be improved in future research with a focus on improvements in mixed method designs that can reveal and predict causal mechanisms of change in social structures such as higher education. Institutions of higher education are premier authorities in comprehending and facilitating learning. The research in causal mechanisms of faculty epistemic belief change is not exhausted and new ways of enhancing learning with the responsibility of teaching should be a primary emphasis of higher education research. Along with responsibility for greater understanding of learning, educators have a responsibility to know how and when learners have truly learned. The pairing of knowing how educators change their epistemic beliefs about assessment and knowing how educators assess learning in higher education has a vast future of exploration.

**Theoretical Implications**

The results of this study have theoretical implications for understanding mechanisms of change that underlie decision-making. Specifically, faculty decision-making about assessment innovations. The following discussion references how findings from this study can clarify and extend the theoretical understanding of the IM-IDM and accounting for components of DI theory (Rogers, 2003). The relevance of these findings are a modification of the IM-IDM design and mechanism of action for change. In addition, the role of epistemic beliefs in decision-making is clarified and expanded.

**IM-IDM design.** One of the primary goals of this study was to test the IM (Bendixen & Rule, 2004) in the context of a new design that accounts for new knowledge as innovative. The IM-IDM design differentiates model components to view the relationships between epistemic beliefs, attributes of knowledge innovativeness, and decision-making that occurs from cyclic processes of weighing attributes of knowledge innovativeness. The clarification of the IM-IDM
through new graphic display of hypothesized components has many theoretical implications. The IM-IDM creates opportunities for continued testing of the hypothesized design, in various audiences and contexts. This modification to the IM (Bendixen & Rule, 2004) and integration of DI components (Rogers, 2003) can be of interest to a broad array of research expertise.

**Limitations**

This mixed methods study was conducted to expand upon existing theory models, but was designed methodologically with a pragmatic view to provide new considerations in methods, procedures, sampling, and research measures that have been absent in higher education literature on assessment. Although exploratory in nature and limited to a faculty population with known characteristics of resistance to an institution-wide focus on assessment, findings of this study may benefit institutions who are wanting to establish faculty development measures and improve assessment practices overall. Thus, although generalizability of findings are limited, the pragmatic design could be useful and replicated at other institutions of higher education.

Limitations of this study are grouped by sampling, instrument, and procedure processes.

**Sampling limitations.** The primary limitation of this study was insufficiency of sample size in the secondary data gained from the institution, and moderate attrition rates of workshop participants limiting power and the ability to determine effects among the independent and dependent variables. Since, secondary data was used in this study to characterize the study population, there were limited demographics included that could be used for further consideration in analysis. Faculty status, teaching discipline, or time teaching at the institution could have provided a different perspective on measurement instrument performance. I chose to simplify groups of faculty to those that derived from the acquired data, and could be compared both quantitatively and qualitatively. Although these faculty groups could be selected for
comparative use in future studies, additional grouping factors may yield significance to other higher education institutions.

**Instrument limitations.** Of the three measurement instruments used by the institution, two were new instruments (i.e., AIS and CLQ) that had only been pilot tested with a limited convenience sample prior to this study. This study conducted a factor analysis to determine convergent and discriminant validity and found some items on both instruments to be similar in nature and other items failed to load within the threshold correlation coefficient I established of .4. However, instrument refinement with a larger and random population of faculty could improve instrument performance. A secondary limitation of measurement instruments was the inability to include the epistemic belief latent variable of SoK in main analysis because all items loaded below the threshold and cross-loaded with the other three epistemic domains. This limitation indicates that the study population may not have comprehended the unique parameters that define SoK epistemic belief. Why this occurred is a relevant inquiry that should be explored since SoK has implications for those at colleges who deliver knowledge to faculty.

The concurrent design of this mixed methods study allowed for independent analysis of each strand. Thus, IN, CL, and SoK that were determined to have no quantitative effect were included in qualitative analyses where they were observed to have an important effect in decision-making. A mixed methods design allowed inclusion of variables that might otherwise be excluded in a traditional quantitative research study. However, these findings are limited to the research population in this study.

**Methodological and procedural limitations.** Methodological factors of workshop design and procedural implementation by the college may have affected participation and retention of the workshop participants. However, the size, participation, and characteristics of
this study population are similar to previous studies of faculty engagement in assessment and professional development interventions (Emil, & Cress, 2014; Estepp, Roberts, & Carter, 2012; Haviland, Shin, & Turley, 2010; Haviland, Turley, & Shin, 2011). Although workshop design and procedures could not be controlled for in this study, this limitation could be managed by including a concurrent research design during workshop implementation. An essential variable in this study was collaborative learning as a teaching strategy for faculty professional development. Independent strand findings were not consistent with the literature. However, the workshop model did not structure collaborative learning to be provided to all participants in the same manner. This limitation can be remedied with modifications to the workshop design and refinement through consistent implementation.

Conclusions

This study brings a different perspective to the research in higher education assessment of learning that has not yet been explored with the examination of epistemic beliefs, innovativeness, and collaborative learning. The mixed methods process revealed a new capacity for studying epistemic beliefs. In addition, I have suggested a broader perspective of how epistemic beliefs are involved in the cognitive processes of decision-making. Furthermore, modifications to the IM are suggested for enhanced understanding of the dynamic process of decision-making in pre-decision and decision stages, and a perpendicular modification to the hypothesized linearity of theorized cognitive processes. These cognitive processes responsible for mechanisms of change require mental activity and behavioral effort. The pragmatic nature of this study can inform a broad array of higher education institutions that are looking for strategies to improve assessment processes at their institutions.
APPENDIX A: EXAMPLE OF A CLASSROOM ASSESSMENT TECHNIQUE (CAT)

Documented Problem Solutions
(Adapted from Angelo & Cross, 1993)

Estimated Levels of Time and Energy Required for:
Faculty- preparation of CAT activity & assessment measure – Low
Student- learning and practice for assessment – Medium
Faculty- analysis of data collected – Medium to High

Description: To become truly proficient problem solvers, students need to learn to do more than just get correct answers to textbook problems. At some point, they need to become aware of how they solved those problems and how they can adapt their problem-solving routines to deal with messy, real-world problems. The Documented Problem Solutions technique prompts students to keep track of the steps they take in solving a problem – to “show and tell” how they worked it out. By analyzing these detailed protocols – in which each solution step is briefly explained in writing – teachers can gain valuable information on their students’ problem-solving skills.

Purpose/Goals: Documented Problem Solutions have three main goals:
1. assess how students solve problems
2. assess how well students understand and can describe their problem-solving methods
3. identify gaps in their problem-solving skills to provide formative instruction and reinforce the steps for learning.

The primary emphasis of the technique is on documenting the specific steps that students take in attempting to solve representative problems – rather than on whether the answers are correct or not.

Suggestions for Use: This CAT is especially useful for assessing problem solving highly quantitative courses but it can be used in other fields that approach problem solving with logic or reasoning in a particular field such as organic chemistry, English grammar, technical fields, music theory, health occupations. The use of case studies or real world problems are highly suggested. This can be conducted as an individual or group activity.

Procedural Steps:
1. Select one – three representative problems from among the problems students have studied during the previous weeks, or an industry-based problem appropriate to the skill level of the students. If you decide to assign three problems: try to select at least one that all the students can solve, another that most of the students can solve, and a third that will challenge most of the students.
2. Solve the problems yourself, and write down all the steps you took in solving them. Note how long it took and how many steps each problem solution required. Replace or revise any problems that are too time-consuming or too complicated.
3. Re-write the problems, making sure that you have enough detain for the students to be able to understand and self-direct their problem solving without having to ask for assistance. Assume that the students will take twice as long as you to solve the problems.

4. Explain the assessment problem(s). In your instructions, explain that the activity is not a test but a learning activity to demonstrate their problem-solving abilities that they have learned. Emphasize that it is more important for them to document and explain in detail how they tried to solve the problems to get the right answers or arrive at an acceptable conclusion. Well-documented steps is more important that a correct answer since you will be able to diagnose where their gaps are and what alternate paths they took. Set a maximum amount of time if this is an in-class activity or this could be given as homework with a set maximum amount of time.

5. Analyzing responses requires skimming through the documented solutions first to identify the pathway they took and their end result. Then go back and make notes on solution paths that led to successful outcomes and last those that led to mistakes.

6. Formative feedback can be given in two suggested formats: (1) locate general zones on problem solving pathways where several steps were missed or incorrect. Provide prompts for what the missed steps should be. (2) locate specific or exact spots for those areas where one error or two errors caused a major deviation and led to incorrect results.

7. Provide three or four main suggestions that you feel they should work on and end your comments with one or two highlights of their abilities.

CAT Adaptations:

- Can be used as a pre-assessment activity and post-assessment activity following instructional concepts.
- Can be used as a small group activity to assess problem solving and their ability to work collaboratively.
- Can be used in conjunction with peer-led discussions afterwards to allow students to share with each other how they arrives as the solution of their problem.
- Can be a non-graded formative assessment activity or a formal summative graded activity after rounds of formative practice.

Pros:

Allows the teacher to determine if students are on task.
Shows what the variance of ability is within the class.

Cons:
Can be time-consuming if the activity is not formally structured.
APPENDIX B: RECRUITMENT LETTER

UNLV

Research Study Recruitment Letter
Department of Educational Psychology and Higher Education

TITLE OF STUDY: Epistemic Beliefs and the Innovation-Decision Process: A Mixed Methods Analysis of Faculty Classroom Assessment Practice

Principal Investigator: Lisa Bendixen, PhD
Student Researcher: Sharon Peterson, MEd, PhD. candidate

Dear Workshop Participant

As an individual who participated in the CAPE workshop series Classroom Assessment Techniques (CATs) during spring or fall 2017, you have been selected to receive this request to participate in a research study focus group. By participating in our focus group, we hope to learn about the cognitive processes of faculty decision-making, and how innovation and collaborative learning influence epistemic belief change. Information about the how the focus group will be conducted and participant expectations are provided in the following informed consent document. This document outlines the purpose of the study, selection of research participants, risks and benefits of participating in this research study, and will provide you with the opportunity to provide consent to participate.

The results generated from this research study will be part of a published dissertation and of value to higher education faculty, administrators, and researchers within the field of academic assessment. Your participation is highly valued and I thank you for your consideration of this opportunity.

Respectfully,

Shari Peterson PhD Candidate
APPENDIX C: INFORMED CONSENT

UNLV

Research Study Informed Consent
Department of Educational Psychology and Higher Education

TITLE OF STUDY: Epistemic Beliefs and the Innovation-Decision Process: A Mixed Methods Analysis of Faculty Classroom Assessment Practice

Principal Investigator: Lisa Bendixen, PhD
Student Researcher: Sharon Peterson, MEd, PhD. candidate

For questions or concerns about the study, you may contact Sharon Peterson at (702) 651-4263.

For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted, contact the UNLV Office of Research Integrity – Human Subjects at 702-895-2794, toll free at 877-895-2794 or via email at IRB@unlv.edu.

Purpose of the Study
As a participant in the CAPE professional development workshop series on Classroom Assessment Techniques (CATs) you are invited to participate in a research study focus group. The purpose of this research study is to explore the cognitive processes of faculty decision-making, and examine how innovation and collaborative learning affect epistemic belief change.

Participants
This opportunity is being provided to randomly selected faculty who participated in the CATs workshop series during the spring 2017 and fall 2017 semesters. The sample population is limited to 30 workshop participants. This research study involves participation in one research focus group.

Focus Group Procedures
Members of the research team will conduct three focus groups at the North Las Vegas campus, building C, conference room A. Research participants will be assigned to one focus group with nine other workshop participants. As a research participant, you will be provided with an overview of participant confidentiality, focus group etiquette, and instructions to be open, frank, and honest about personal experiences. Ten open-ended questions will be used to direct discussions about faculty perceptions and experiences while participating in the workshop series on CATs. Each discussion question relates to cognitive processes and mechanisms of change in decision-making. You may decline to answer any question at any time during the focus group discussion and you may choose to withdraw from the research study at any time. A focus group session will last approximately one (1) hour. Audio recording will be used during the focus groups to assure accuracy when researchers transcribe discussion information for data analysis.

Benefits of Participation
There should not be any direct benefits to your participation in this study. It is not likely that your perceptions and experiences revealed during the focus group will provide any benefit or harm differently than those who do not consent to participate in a focus group. Discussions that occur during a focus
group should not be any different from ordinary discussions or interactions encountered at work. However, we hope that responses to the focus group questions will help us learn about the cognitive processes that occur when faculty make decisions while learning about an innovative method to assess student learning.

**Risks of Participation**
There are risks involved in all research studies. This study may include only minimal risks to you as identified in the focus group procedures. You are encouraged to contact the student researcher for clarification of participation expectations or questions you may have about the focus group procedures.

**Cost /Compensation**
There will not be any financial cost to you if you participate in this study and you will not be compensated for your participation.

**Confidentiality**
This research study is being conducted as part of a dissertation that the student researcher intends to submit for publication. All information gathered and used in this study will be kept as confidential as possible. No reference will be made in written or oral materials that could link you to this study. A fictitious name and unique research identifier will be assigned to you and your responses to the focus group questions. Only members of the research team will have access to your personal information used in this research study and no personal information used during this research study will be released to your employer. All electronic research data collected and used in this study will be maintained in a password-protected computer file known only to the research team members. At the conclusion of the study, the password-protected computer file will be removed from the research team computers, transferred to a password-protected flash drive and stored in a locked drawer of the student researcher’s office at CSN. After three years, the flash drive will be reformatted to remove all data and consent forms shredded.

**Voluntary Participation**
Participation in this study is voluntary. You may refuse to answer any focus group question, refuse to participate in focus group discussions, or withdraw from this study at any time without any prejudice or impact to employment. You are encouraged to ask questions about this study and may do so at any time during the research study.

Please download a copy of this informed consent document for future reference.

*Would you be willing to meet for one (1) hour to discuss your perceptions and experiences of participating in the workshop series on CATs?*

If so, please complete the following consent to participate and inter-office mail the consent form to Shari Peterson at CYC 2626 or bring with you to the focus group session.

**Participant Consent**
I provide consent to participate in a focus group discussion according to the procedures outlined in the informed consent document. I acknowledge that an audio recording of the focus group is used to assure accuracy of data collection.

Participant Signature __________________________________________________________

Print Name__________________________________ Date _________________________
APPENDIX D: REQUEST FOR CONSENT TO USE SECONDARY DATA

Request for Consent to Use Secondary Data
Department of Educational Psychology and Higher Education

TITLE OF STUDY: Epistemic Beliefs and the Innovation-Decision Process: A Mixed Methods Analysis of Faculty Classroom Assessment Practice

Principal Investigator: Lisa Bendixen, PhD
Student Researcher: Sharon Peterson, MEd, PhD. candidate

Dear Associate Vice President,

My research team and I are conducting a study to examine the cognitive processes of faculty decision-making, and how innovation and collaborative learning mediate epistemic belief change. As the chief administrator of the Center for Academic and Professional Excellence (CAPE) you are receiving this notification because CAPE offers a professional development workshop series at College of Southern Nevada (CSN) titled: Classroom Assessment Techniques (CATs) to teach faculty simple, authentic assessment activities and change faculty methods of assessment. We would like to request your help in facilitating our research by allowing us to obtain a copy of the data collected during the spring and fall 2017 workshop series, as well as obtain a list of the workshop participants and their CSN email addresses. The current study will involve analyzing the collected data and conducting focus groups with a random sample of workshop participants.

The assessment data we would like to use includes:

- Pre and post-test on faculty epistemic beliefs about assessment of student learning
- Survey on collaborative learning
- Survey on the innovativeness of CATs and faculty decision to adopt CATs

I will provide a new 8GB flash drive to you for download of the requested items. As the student researcher, I will upload the data from the flash drive into a password-protected file on my CSN computer to de-identify the workshop data and assign unique research identifiers for use in this study. The participant list will be stratified into three categories 1) adopters of CATs, 2) rejecters of CATs, and 3) workshop non-completers. A process of random selection will be
used to solicit individuals within each group for participation in our research study focus groups. The recruitment letter will introduce the research procedures, and an informed consent form outlines the risks and benefits of participating in a focus group. Those individuals who consent to participate will sign and send the informed consent form to me through CSN inter-office mail.

The flash drive of data you provide and informed consent forms will be stored in a locked-file cabinet in my office at CSN. Only members of the research team will have access to the password-protected research data file for download and use on their computers. At the conclusion of the study, all research data files will be removed from the research team computers, transferred to the flash drive, and stored in the locked-file cabinet of my office. After three years, the flash drive will be reformatted to remove all data, and consent forms shredded.

The results generated from this research study will be part of a published dissertation and of value to higher education faculty, administrators, and researchers within the field of academic assessment. Your participation is highly valued and integral as we both share common goals of understanding faculty needs and promoting a highly effective faculty workforce. Please contact me at the number listed below if you have any questions about this study or your participation.

Respectfully,

Sharon Peterson, M.Ed., PhD Candidate
(702) 651-4263

Research team:
Principal Investigator: Lisa Bendixen, PhD
Student Researcher: Sharon Peterson, MEd, PhD Candidate
Researcher: Shellie Keller, PhD
Researcher: Pam Gallion, MEd., MBA
APPENDIX E: ASSESSMENT OF LEARNING EPISTEMIC BELIEFS

QUESTIONNAIRE (ALEBQ)

(Adapted from Braten, Gil, Stromso, Vidal-Abarca, 2009)

The following questions concern knowledge about assessment of learning in higher education and how one comes to know about assessment of learning in higher education. There are no right or wrong answers to these questions; it is your personal beliefs that are of interest. Use the scale below to answer the questions. If you strongly agree with a statement, enter 10; if you strongly disagree, enter 1. If you more or less agree with a statement, circle the number between 1 and 10 that best expresses your belief.

Strongly Disagree 1 2 3 4 5 6 7 8 9 Strongly Agree 10

Certain Knowledge
1. What is considered to be certain knowledge about assessment of learning today, may be considered to be false tomorrow
2. Certain knowledge about assessment of learning is rare
3. The results of assessment of learning research are preliminary
4. Theories about assessment of learning can be disproved at any time
5. The knowledge about issues concerning assessment of learning is constantly changing
6. Problems within assessment of learning research do not have any clear and unambiguous solution

Simplicity of Knowledge
7. With respect to knowledge about assessment of learning, there are seldom connections among different issues (R)
8. Within assessment of learning research, accurate knowledge about details is the most important (R)
9. Within assessment of learning research, various theories about the same will make things unnecessary complicated (R)
10. Knowledge about assessment of learning is primarily characterized by a large amount of detailed information (R)
11. The knowledge about assessment of learning problems is indisputable (R)
12. There is really no method I can use to decide whether claims in texts about issues concerning assessment of learning can be trusted (R)

Source of Knowledge
13. I often feel that I just have to accept that what I read about assessment of learning problems can be trusted (R)
14. When I read about issues concerning assessment of learning, the author’s opinion is more important than mine (R)
15. With respect to *assessment of learning* problems, I feel I am on safe ground if I only find an expert statement (R).
16. When I read about *assessment of learning* problems, I only stick to what the text expresses (R).
17. My personal judgments about *assessment of learning* problems have little value compared to what I can learn about them from books and articles (R).

Justification of Knowledge

18. To check whether what I read about *assessment of learning* problems is reliable, I try to evaluate it in relation to other things I have learned about the topic.
19. When I read about issues related to *assessment of learning*, I try to form my own understanding of the content.
20. To gain real insight into issues related to *assessment of learning*, one has to form one’s own personal opinion of what one reads.
21. When I read about issues concerning *assessment of learning* I evaluate whether the content seems logical.
22. To be able to trust knowledge claims in texts about issues concerning *assessment of learning*, one has to check various knowledge sources.
23. Within *assessment of learning* research, there are connections among many topics.
24. I understand issues related to *assessment of learning* better when I think through them myself, and not only read about them.
APPENDIX F: COLLABORATIVE LEARNING QUESTIONNAIRE (CLQ)

Adapted from So & Brush (2008)

Instructions: The following questions are designed to measure your perception of two levels of development as you experienced collaborative learning in this workshop series. There are no right or wrong answers to these questions; it is your personal beliefs that are of interest. Use the scale below to answer the questions. If you strongly agree with a statement, enter 10; if you strongly disagree, enter 1. If you more or less agree with a statement, click on the number between 1 and 10 that best expresses your belief.

Strongly Disagree                      Strongly Agree
1    2    3    4    5    6    7    8    9    10

**Individual development within a group**
1. I felt part of a learning community in my cohort.
2. I actively exchanged my ideas with cohort members.
3. I was able to develop new skills and knowledge from other members in my cohort.
4. I was able to develop problem-solving skills through peer collaboration.

**Group development of individuals**
5. Collaborative learning in my cohort was effective.
6. Collaborative learning in my cohort was time consuming.
7. Collaborative learning with my cohorts helped me to view assessment of learning in a different way.
8. Collaborative learning with my cohorts influenced my opinion about the innovativeness of classroom assessment techniques.
APPENDIX G: ATTRIBUTES OF INNOVATIONS SURVEY (AIS)

The following questions measure five parameters of the attributes of innovations (relative advantage, compatibility, complexity, trialability, and observability), and consider classroom assessment techniques (CATs) as an innovation in conducting assessment at the institution. There are no right or wrong answers to these questions; it is your personal beliefs that are of interest. Use the scale below to answer the questions. If you strongly agree with a statement, enter (10); if you strongly disagree, enter (1). If you more or less agree with a statement, click on the number between 1 and 10 that best expresses your belief.

Strongly Disagree 1 2 3 4 5 6 7 8 9 Strongly Agree 10

Relative Advantage
1. Using a classroom assessment technique is a better method to assess and report achievement of student learning outcomes than the previous method that I was using to assess and report achievement of student learning outcomes.
2. Using a classroom assessment technique for assessment of student learning is not efficient. (R)

Compatibility
3. Using a classroom assessment technique is compatible with my teaching and learning philosophy.
4. Using a classroom assessment technique is compatible with my value of the assessment process.
5. Using a classroom assessment technique is compatible with the time I allocate for teaching preparation.

Complexity
6. Using a classroom assessment technique is challenging but I was able to understand and use the technique.
7. Using a classroom assessment technique is complex and a barrier to my adopting the CAT into my teaching practice. (R)

Trialability
8. Practice creating a classroom assessment technique has influenced my decision about assessing and reporting achievement of student learning outcomes.
9. Practice creating a classroom assessment technique has shown me how to customize or re-invent assessment to fit my teaching practice needs.

Observability
10. I can see how classroom assessment techniques inform students of their abilities and can be grading measures.

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11. I can see how classroom assessment techniques measure student performance and contribute to institutional effectiveness.
12. Using classroom assessment techniques will provide evidence to others for assessing program and institutional outcomes.
**APPENDIX H: TYPE OF DECISION SCALE**

Select the following choice that best describes your decision about adopting CATs in your teaching practice.

<table>
<thead>
<tr>
<th></th>
<th>Type of Decision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Adoption</td>
<td>Have implemented the CAT and am making full-use of the materials as presented</td>
</tr>
<tr>
<td>4</td>
<td>Adoption/Re-invented</td>
<td>Have implemented aspects of the CAT or have modified the activity materials as presented and implemented the modifications</td>
</tr>
<tr>
<td>3</td>
<td>Later Adoption</td>
<td>Have implemented some aspects of the CAT, still practicing with the concept. Likely to implement the CAT in the future</td>
</tr>
<tr>
<td>2</td>
<td>Discontinuance</td>
<td>Have implemented some or all of the CAT. However, I have discontinued using the CAT</td>
</tr>
<tr>
<td>1</td>
<td>Rejection</td>
<td>Have not implemented the CAT and do not intend to implement it in the future</td>
</tr>
</tbody>
</table>
APPENDIX I: FOCUS GROUP QUESTIONS

Epistemic doubt
1. How did the knowledge about CATs cause you to reconsider or question your old knowledge about classroom assessment?

Affect
2. How did knowledge about CATs affect your emotions about classroom assessment?

Epistemic volition
3. Describe the choices you considered when learning about CATs?
4. Describe the decision-making processes you used when choosing to adopt CATs?

Resolution strategies
5. Describe how reflection on your old knowledge about classroom assessment influenced your decision-making about CATs?
6. Describe how participation in the CATs learning experience influenced your decision-making about CATs?
7. Describe the changes you made to your old classroom assessment methods through accommodation (replacing your existing classroom assessment methods with a CAT) or assimilation (modifying a CAT to fit your existing classroom assessment methods?)

Reciprocal causation
8. How did working in collaborative groups influence the new knowledge about CATs and decision to adopt CATs?
9. How did change in your group member’s knowledge influence your learning about CATs?

Metacognition
10. How did the workshop series change the sophistication of your beliefs about assessment?
## APPENDIX J: WORKSHOP SERIES COLLABORATIVE GROUPS

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<thead>
<tr>
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<th>C</th>
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<td>C</td>
<td>S</td>
<td>C</td>
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<td>GROUP 3</td>
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<td>GROUP 4</td>
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<td>TOTALS</td>
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<td>25</td>
<td>21</td>
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</table>

*Notes. S = started workshop, C = completed workshop*

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<th>C</th>
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<td>S</td>
<td>C</td>
<td>S</td>
<td>C</td>
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<td>GROUP 1</td>
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<td>GROUP 4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
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<td>TOTALS</td>
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<td>18</td>
<td>22</td>
<td>17</td>
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</table>

*Notes. S = started workshop, C = completed workshop*
## APPENDIX K: EXPLORATORY FACTOR ANALYSIS ITEMS

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<tr>
<th>Item</th>
<th>Factor Loading</th>
<th>$h^2$</th>
<th>$M$</th>
<th>$SD$</th>
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<tr>
<td><strong>Factor one (8 items)</strong></td>
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<tr>
<td>CL5: Peer collaboration helped me with problem solving skills.</td>
<td>.99</td>
<td>.98</td>
<td>7.57</td>
<td>2.38</td>
</tr>
<tr>
<td>CL3: I actively exchanged my ideas with group members.</td>
<td>.96</td>
<td>.91</td>
<td>7.57</td>
<td>2.27</td>
</tr>
<tr>
<td>CL6: Collaborative learning in my group was effective.</td>
<td>.95</td>
<td>.90</td>
<td>7.76</td>
<td>2.09</td>
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<tr>
<td>CL8: Collaborative learning influenced my opinions about the</td>
<td>.90</td>
<td>.83</td>
<td>7.46</td>
<td>2.18</td>
</tr>
<tr>
<td>innovativeness of the assessment concepts I practiced in the</td>
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<td></td>
<td></td>
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<tr>
<td>workshop.</td>
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<tr>
<td>CL1: The collaborative learning experience in the workshops was a</td>
<td>.89</td>
<td>.81</td>
<td>7.51</td>
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<tr>
<td>better learning environment than a traditional workshop learning</td>
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<td></td>
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<tr>
<td>environment.</td>
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<tr>
<td>CL2: Collaborative learning encouraged me to be a part of a cohort.</td>
<td>.78</td>
<td>.65</td>
<td>7.60</td>
<td>2.39</td>
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<tr>
<td>CL4: The other members of my group helped me to develop new skills</td>
<td>.70</td>
<td>.50</td>
<td>7.36</td>
<td>2.37</td>
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<td>and knowledge.</td>
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<td>CL7: Collaborative learning in my group was time consuming (R).</td>
<td>.32</td>
<td>.11</td>
<td>7.13</td>
<td>2.08</td>
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<td><strong>Factor two (12 items)</strong></td>
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<td>IN8: Practice creating a classroom assessment technique has</td>
<td>.93</td>
<td>.87</td>
<td>8.82</td>
<td>1.12</td>
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<tr>
<td>influenced my decision about assessing and reporting achievement of</td>
<td></td>
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<td></td>
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<tr>
<td>student learning outcomes.</td>
<td></td>
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<tr>
<td>IN11: I can see how classroom assessment techniques measure student</td>
<td>.91</td>
<td>.83</td>
<td>8.87</td>
<td>1.22</td>
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<tr>
<td>performance and contribute to institutional effectiveness.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IN10: I can see how classroom assessment techniques inform students</td>
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<td>.77</td>
<td>8.69</td>
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<tr>
<td>of their abilities and can be grading measures.</td>
<td></td>
<td></td>
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<tr>
<td>IN9: Practice creating a classroom assessment technique has shown me</td>
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<td>.78</td>
<td>8.85</td>
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<td>how to customize or re-invent assessment to fit my teaching</td>
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<td>practice needs.</td>
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<td>IN4: Using a classroom assessment technique is compatible with my</td>
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<td>.53</td>
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<td>value of the assessment process</td>
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<td>IN6: Using a classroom assessment technique is challenging but I was</td>
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<td>.49</td>
<td>8.38</td>
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<tr>
<td>able to understand and use the technique</td>
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<td></td>
</tr>
<tr>
<td>IN5: Using a classroom assessment technique is compatible with the</td>
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<td>.47</td>
<td>7.77</td>
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<tr>
<td>time I allocate for teaching preparation</td>
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<td>IN3: Using a classroom assessment technique is compatible with my</td>
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<td>.26</td>
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<td>teaching and learning philosophy</td>
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<tr>
<td>IN7: Using a classroom assessment technique is complex and a barrier</td>
<td>.46</td>
<td>.22</td>
<td>8.13</td>
<td>1.29</td>
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<tr>
<td>to my adopting the CAT into my teaching practice (R)</td>
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<tr>
<td>IN2: Using a classroom assessment technique for assessment of student</td>
<td>.41*</td>
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<td>learning is not efficient. (R)</td>
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<tr>
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<tr>
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<td>that the previous method that I was using to assess and report</td>
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<td>achievement of student learning outcomes.</td>
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<tr>
<td>IN12: Using classroom assessment techniques will provide evidence to</td>
<td>.37</td>
<td>.18</td>
<td>8.82</td>
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<td>others for assessing program and institutional outcomes.</td>
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</tbody>
</table>
**Factor three (8 items)**  
JK4: When I read about issues concerning assessment of student learning, I evaluate whether the content seems logical  
JK3: To gain real insight into issues related to assessment of student learning, one has to form one’s own personal opinion of what one reads  
JK7: I understand issues related to assessment of student learning better when I think through them myself, and not only read about them  
JK2: When I read about issues related to assessment of student learning, I try to form my own understanding of the content  
JK6: Within assessment of student learning research, there are connections among many topics  
JK5: To be able to trust knowledge claims in texts about issues concerning assessment of student learning, one has to check various knowledge sources  
JK1: To check whether what I read about assessment of student learning problems is reliable, I try to evaluate it in relation to other things I have learned about the topic  
SoK4: When I read about assessment of student learning problems, I only stick to what the text expresses (R)  

<table>
<thead>
<tr>
<th>Item</th>
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<td>JK7</td>
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<tr>
<td>JK2</td>
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**Factor four (8 items)**  
CK1: What is considered to be certain knowledge about assessment of student learning today, may be considered to be false tomorrow  
CK5: The knowledge about issues concerning assessment of student learning is constantly changing  
CK3: The results of assessment of student learning research are preliminary  
CK2: Certain knowledge about assessment of student learning is rare  
CK4: Theories about assessment of student learning can be disproved at any time  
CK6: Problems within assessment of student learning research do not have any clear and unambiguous solution  
SoK2: When I read about issues concerning assessment of student learning, the author’s opinion is more important than mine (R)  
SoK3: With respect to assessment of student learning problems, I feel I am on safe ground if I only find an expert statement (R)  

<table>
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<th>Factor four</th>
<th>Factor four</th>
<th>Factor four</th>
<th>Factor four</th>
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**Factor five (8 items)**  
SK3: Within assessment of student learning research, various theories about the same will make things unnecessary complicated (R)  
SK1: With respect to knowledge about assessment of student learning, there are seldom connections among different issues (R)  
SK4: Knowledge about assessment of student learning is primarily characterized by a large amount of detailed information (R)  
SK2: Within assessment of student learning research, accurate knowledge about details is the most important (R)  
SoK1: I often feel that I just have to accept that what I read about assessment of student learning problems can be trusted (R)  

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170
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<th>Item</th>
<th>Statement</th>
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<th>Loading (IN)</th>
<th>Loading (JK)</th>
<th>Loading (SoK)</th>
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<tr>
<td>SK5</td>
<td>The knowledge about assessment of student learning problems is indisputable (R)</td>
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<td>SoK5</td>
<td>My personal judgments about assessment of student learning problems have little value compared to what I can learn about them from books and articles (R)</td>
<td>.26</td>
<td>.18</td>
<td>7.95</td>
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<tr>
<td>SK6</td>
<td>There is really no method I can use to decide whether claims in texts about issues concerning assessment of student learning can be trusted (R)</td>
<td>.25</td>
<td>.09</td>
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</table>

* cross loadings < .3. h² = communality estimates.
Notes. e = error. CL = collaborative learning. IN = innovativeness. JK = justification for knowing. CK = certainty of knowledge. SK = simplicity of knowledge.
APPENDIX M: SEM MEDIATION ANALYSES MODELS

Model One

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<tr>
<th>Paths</th>
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<td>-.183 **</td>
<td>.034 (ns)</td>
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Notes. CK = certainty of knowledge. JK = justification for knowing. SK = simplicity of knowledge. ns = not significant
** = p < .05
Model Two

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<td>.160 (ns)</td>
<td>.169 (ns)</td>
<td>-.038 (ns)</td>
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Notes. JK = justification for knowing. CK = certainty of knowledge. SK = simplicity of knowledge. ns = not significant.
Model Three

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<td>.295 **</td>
<td>.258 **</td>
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Notes. JK = justification for knowing. SK = simplicity of knowledge. CK = certainty of knowledge. ns = not significant. ** = p < .05.
Model Four

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<td>-.188 (ns)</td>
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Notes. SK = simplicity of knowledge. JK = justification for knowing. CK = certainty of knowledge. ns = not significant.
Model Five

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Notes. CK = certainty of knowledge. SK = simplicity of knowledge. JK = justification for knowing. ns = not significant.

** = p < .05.
Model Six

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Notes. SK = simplicity of knowledge. CK = certainty of knowledge. JK = justification for knowing. ns = not significant. ** = p < .05.
## APPENDIX N: CODE BOOK

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10.5.3 Concern: Not able to recognize/distinguish cognitive difference 2
10.5.4 Barier: Not motivated to complete workshop activities 6
10.5.5 Barrier: Limited prior knowledge of assessment 14
10.5.6 Concern: Peers have limited knowledge about assessment 11

7 Epistemic Beliefs
7.1 Epistemic Beliefs\Simplicity of Knowledge
knowledge is an accumulation of facts / knowledge is highly integrated concepts

7.2 Epistemic Beliefs\Source of Knowledge
Knowledge acquired passively from authoritative sources / knowledge constructed through interaction with others.

7.3 Epistemic Beliefs\Justification for Knowing
knowledge justified by what feels right / justified by rules of inquiry and reason

7.4 Epistemic Beliefs\Certainty of Knowledge
Certain that absolute truth exists / knowledge is uncertain, tentative and evolving

8 Cognitive Decision-making Processes

8.1 Cognitive Decision-making Processes\Epistemic Doubt
Questioning one's beliefs about knowledge or knowing, doubting some or all aspects of existing epistemic belief about classroom assessment

8.1.1 Cognitive Decision-making Processes\Epistemic Doubt\Choice
Selection of options. No justification, reasoning or decisions

8.2 Cognitive Decision-making Processes\Epistemic volition- cue to action
Controlled individual choice to initiate a change in epistemic belief about classroom assessment

8.2.1 Cognitive Decision-making Processes\Epistemic volition- cue to action\Decisions/Decision-making
To make full use of the innovation

8.3 Cognitive Decision-making Processes\Affect
Emotion that can constrain and or facilitate epistemological development of beliefs

8.3.1 Cognitive Decision-making Processes\Affect\Emotion
8.4 Cognitive Decision-making Processes\Resolution Strategies
Actions taken by individuals to sustain or reinforce a change in epistemic belief (reflection, social interaction, accommodation, assimilation)

8.4.1 Cognitive Decision-making Processes\Resolution Strategies\Participation

8.4.2 Cognitive Decision-making Processes\Resolution Strategies\Accommodation/Assimilation

8.4.3 Cognitive Decision-making Processes\Resolution Strategies\Collaborate

8.4.4 Cognitive Decision-making Processes\Resolution Strategies\Reflection

8.5 Cognitive Decision-making Processes\Reciprocal Causation
Personal epistemologies or feedback among others that influence an individual's epistemic beliefs.

8.6 Cognitive Decision-making Processes\Metacognition
Individual not only thinks about thinking but knows about their knowing, beliefs, and learning processes including self-reflection or verbalization of ideas

8.6.1 Cognitive Decision-making Processes\Metacognition\Recognize change in beliefs
4 Conditions for change (Bendixen, 1993)
1. Dissatisfaction with current conceptions
2. New conceptions intelligible
3. New conceptions plausible
4. New conceptions must have potential to improve/ evolve

9 Collaborative Learning Experience
Working together within small groups to complete complex tasks both in class and online

9.1 Collaborative Learning Experience\Collaborative learning was not effective

9.1.1 Collaborative Learning Experience\Collaborative learning was not effective\Group diversity was a negative

9.2 Collaborative Learning Experience\Collaborative learning was effective

9.2.1 Collaborative Learning Experience\Collaborative learning was effective\Online peer review was effective

9.2.2 Collaborative Learning Experience\Collaborative learning was effective\Group diversity was a positive
10 Persuasion-Attributes of Innovativeness

10.1 Persuasion-Attributes of Innovativeness\Observability
Degree of visibility/Results

10.1.1 Persuasion-Attributes of Innovativeness\Observability\Transferred workshop learning to others or other situations

10.1.2 Persuasion-Attributes of Innovativeness\Observability\Use as a communication tool

10.1.3 Persuasion-Attributes of Innovativeness\Observability\More than just testing

10.2 Persuasion-Attributes of Innovativeness\Compatibility
Consistent with needs, values, beliefs, and existing practice

10.2.1 Persuasion-Attributes of Innovativeness\Compatibility\Beliefs: better teaching decisions

10.2.2 Persuasion-Attributes of Innovativeness\Compatibility\Values: quality assessment

10.2.3 Persuasion-Attributes of Innovativeness\Compatibility\Needs: clearer understanding

10.2.4 Persuasion-Attributes of Innovativeness\Compatibility\Needs: motivation

10.3 Persuasion-Attributes of Innovativeness\Relative Advantage
Profitability or benefit/social status

10.3.1 Persuasion-Attributes of Innovativeness\Relative Advantage\Profitability: Improved teaching ability

10.3.2 Persuasion-Attributes of Innovativeness\Relative Advantage\Profitability: assessment terminology

10.3.3 Persuasion-Attributes of Innovativeness\Relative Advantage\Profitability: variety of resources

10.3.4 Persuasion-Attributes of Innovativeness\Relative Advantage\Social: culture of assessment

10.3.5 Persuasion-Attributes of Innovativeness\Relative Advantage\Profitability: authentic assessment experiences
10.4 Persuasion-Attributes of Innovativeness\Trialability
Degree of experimentation

10.4.1 Persuasion-Attributes of Innovativeness\Trialability\Experimentation: CATs

10.4.2 Persuasion-Attributes of Innovativeness\Trialability\Experimentation: rubrics

10.4.3 Persuasion-Attributes of Innovativeness\Trialability\Experimentation: curriculum mapping

10.4.4 Persuasion-Attributes of Innovativeness\Trialability\Experimentation: workshop activities

10.5 Persuasion-Attributes of Innovativeness\Complexity
Difficulty to understand or use

10.5.1 Persuasion-Attributes of Innovativeness\Complexity\Barrier: Resistant to new knowledge

10.5.2 Persuasion-Attributes of Innovativeness\Complexity\Barrier: Did not complete activities or implement CATs

10.5.3 Persuasion-Attributes of Innovativeness\Complexity\Concern: Not able to recognize/distinguish cognitive difference

10.5.4 Persuasion-Attributes of Innovativeness\Complexity\Barrier: Not motivated to complete workshop activities

10.5.5 Persuasion-Attributes of Innovativeness\Complexity\Barrier: Limited prior knowledge of assessment

10.5.6 Persuasion-Attributes of Innovativeness\Complexity\Concern: Peers have limited knowledge about assessment

10.5.7 Persuasion-Attributes of Innovativeness\Complexity\Barrier: Time demands
Focus Group 1- Spring Series Completers

**Moderator:** Q1 (Epistemic doubt) How did the knowledge about CATs cause you to reconsider or question your old knowledge about classroom assessment?

**Ann:** It made me think about how clear I needed to be in my teaching, I mean how clear I hadn’t been in communicating directions for my assignments. I took some of the assignments that I was giving as homework and I didn’t change the grading, but I changed the grading to a rubric format to make it more objective. For me it made assessment more clear, not in terms of what the students needed to do, but in terms of how I was going to be conducting my grading. I had specific criteria to look at, a listing of how the points were going to be awarded, and how heavily the point categories were weighted and so forth. It allowed me to communicate my expectations of performance to the students and I think it helped them prepare better for their homework.

**Barbara:** What I learned made me consider different ways of grading also. I was just entering scores and not giving feedback. Like Ann, I was also grading without using rubrics. I knew about rubrics I just wasn’t interested in using them before because they looked like they took too much time to create. It was just easier to assign points and not use criteria for grading. I’ve been teaching for so many years now, I know good student work. I know an A paper from a B and C paper. However, the workshop made me change the way I looked at grading. After the first workshop I starting using some of the activities and a rubric in one of my classes just to test them out. If they didn’t work then I wouldn’t have come back for the rest of the workshops.

**Carl:** So I guess they worked for you. What I learned was a test alone is not enough to assess course outcomes; you need to have a measurement instrument that can actually measure demonstrated ability and documentation is really important because its evidence that the student has learned. And what I learned differently was how to document my assessment activities and measures correctly as evidence for what was expected in college reports.

**Ann:** Ya, and I would say going along with documenting what we are doing, part of that was a confirmation of “oh yeah, that’s why they ask us to do that”, or why we should be doing that.

**Barbara:** For me it was enlightening too but in a different way. I was pretty negative at first but then I got the big picture by Workshop 2 and could finally relax and absorb things. When I started the workshops I felt documenting what I was doing in the classroom so that others could know was a threat to my academic freedom I mean to teach how I wanted and not have to conform to a standardized curriculum. Documenting my curriculum made me feel threatened. I knew how to teach, but I didn’t know assessment involved documenting evidence of learning and then turning it in for reporting. We've never done that here before so I wasn’t even clear on what data to gather or what was needed for documentation. But the workshops didn't just tell you what to do, they walked you through the process and since we were with our fellow faculty we could ask questions when we were unsure about what we were learning or why we were doing things.
Carl: Ya the documentation helped me to double check that I was doing it all correct. (all agree)

Gwen: So, I started keeping track of the assignments I was giving to my students and found some were relevant and some weren’t. The documentation process helped me to figure out what I was teaching and then if it was connected to what students were supposed to be learning. I’ve actually come up with a way to document what I’m doing with my course and it tells me how to do things better in my course for the next semester. It helps me to see whether I have been giving students enough practice or feedback before a test.

Donna: Well, the curriculum mapping process that teaches curriculum alignment, I guess that’s what you are calling documentation, it taught me why you have course SLOs and why they should be used as a guide for building the course curriculum. The mapping helped me to see that most of the assessments I was using were tests and it was really the assignments where students were practicing their skills. But it was just a check off. If they did it they got the points. I wasn’t really giving them any feedback on their homework. Then they would just test. (all heads nod) So the only assessment of their ability was the grade. When I looked back at the homework they were explaining things correctly but they struggled with the matching and recognition on the test.

Evan: Ya, same for me. I thought assessment was just tests and grades. Students hate tests and being graded no wonder faculty hate the word assessment. Maybe its because they don’t feel confident in the way they assign grades. Actually I take that back. Students earn a grade but we as faculty set up the path to earn the grade. If the path is only summative measures of tests without any formative activities then no wonder faculty hate assessment because maybe they know that how their students are performing really aren’t the best they can do. Maybe they really aren’t teaching so they can learn. They won’t admit that and there’s no way to really check on that. But I bet it goes on a lot especially in courses that are just lecture, test, grade, goodbye.

Frank: Ya, tests and grades that’s all they ask us to do in my department. Everything is pretty standardized cause we teach a lot of Gen Ed courses and they have to match up with what the university teaches. So there isn’t really a lot of creativity. The tests are the only thing we can quantify between the college and university to show that our courses are the same. I guess the department is the ones who keep tabs on that.

Gwen: I remember learning something in the workshop and it was so profound it was like I had a total reversal of my previous thinking. When we talked about grades being compensatory and just a bag of jumbled points. She said a letter grade only equates to points, it doesn’t distinguish between how well the outcome ability was demonstrated, something like that. I remember discussing in my group how a good performance can compensate for a bad performance and average to a passing performance of a C. But the student wouldn’t be competent in the ability that they were supposed to demonstrate in the failed assignment, and then a passing grade is a false indicator of ability. From that point on I changed my entire thought process about grading and scrutinized how my points were adding up, how many points I gave to my assignments. I learned that students could pass all their quizzes in my course, fail the final exam and still pass the course. I was trying to be lenient with points because students typically bomb my final. So now I look at everything twice over and spent almost all of last summer revising the point totals
for my courses. I even tested out scenarios based on some past student performance to make
sure that students really had to earn a grade to pass my courses.

**Harold:** For me I’ve only been here a year and a half and so I have limited knowledge of student
assessment especially since I come from the technology world. I give tests because that’s
expected in college. But in the technology world that’s not reality. You aren’t going to be going
to your job in the morning and be expected to pass a test on what you know every day for you to
do your job, they expect you to jump in and do your job. You have to be able to reason and
justify and solve the problem that’s in front of you. That’s one of the biggest things that I got out
of the workshop series is all the different CAT activities that allow you to create real world
experiences for assignments and activities in class and determine whether my students are ready
for the real world. I found many of the CATs fit in my field and I think that students want
activities and to participate rather than to sit and listen to me babble on.

**Evan:** I think many of us can relate to that (all heads nod)

**Barbara:** You know the knowledge I gained helped me to prepare for writing my accreditation
self-study, and what they required for documenting achievement of student competencies. I
found there are common elements and it helped me to understand what was expected of me as a
program director.

**Ann:** Me too, I’m doing that right now. We have a site visit this semester.

**Harold:** So what I gained from the workshop was a broad exposure to a variety of assessment
techniques that I had never heard of before (2 agree). I mostly teach technology labs but some I
could use and some I couldn’t. But I started thinking about other people’s courses and how some
of the CATs would work in their courses.

**Moderator:** Q2 (Affect) How did knowledge about CATs affect your emotions about classroom
assessment?

**Carl:** I was just anxious, a little intimidated because I was nervous to learn that I didn’t know
something about teaching things I had never been taught before or that I’d never heard of before
it made me feel inferior as a teacher. But being there with others that were in the same boat, I got
over that feeling pretty quickly within the first half of the first workshop.

**Barbara:** You know I was actually excited. I signed up for the workshop because I’m always
looking at different options and ways to teach to keep things interesting for my students. There
is so much to assessment I don’t think I will ever get bored.

**Donna:** I actually felt ashamed when I went through the alignment process. I’ve been teaching
for a while and I learned that my assessments weren’t aligned with my outcomes. I never
thought of teaching in such a formal way. Mainly because I wasn’t mentored through this
process. I was just expected to walk in and wing it.

**Ann:** I was overwhelmed with all the knowledge and concepts. It was a good thing I had a
month to absorb all the information before coming back and learning additional information. I also remember feeling a bit lost because everything was so clear in the workshop and I have all these ideas but once I left the workshop all I could think about was how do I apply this knowledge?

**Evan:** ya me too. (3-4 heads nod)

**Gwen:** At first I was confused when I first started reviewing my homework assignments. I remember thinking to myself “am I doing this correctly?” and “am I remembering everything the way that I was taught”.

**Moderator:** Q3 (Epistemic volition- choice) Describe the choices you considered when learning about CATs?

**Ann:** Where is the best place to start? Where can I apply this to my curriculum?

**Carl:** So part of what I learned was that you need to start curriculum development first with the outcomes. If I didn’t have good outcomes then nothing else was going to fall into place. So since my course wasn’t based on outcomes I had to decide "do I need to make big changes to repair things and make things right?" or "can I make little change[s] and slowly correct things?". I’ll get back to you on that and let you know.

**Evan:** I was just given a syllabus that had outcomes that weren’t measurable but I had to find a way to teach students and to assess them accurately. I was told I could do anything with the course I just couldn’t make any changes to the outcomes. So I chose to ask why? Why couldn’t there be any changes to the outcomes? Especially if they weren’t measurable. That just seemed illogical. I asked a lot of questions until I found my answer which was it was someone else’s job to take curriculum requests to the curriculum committee and no one wanted to do it. So I decided to step up to the plate and I asked my Chair if I could submit the changes and he said yes. He even helped me with the revisions.

**Frank:** For me it was a matter of learning. That I could choose to change things in the curriculum. Our department has prescribed tests set points that we must follow so I focused on a lot of non-graded assessment techniques and more formative assessment

**Harold:** One choice was how much time I was willing to spend on assessment. I thought if I choose to invest time into developing good assessment methods then it should make my job easier to determine student ability.

**Donna:** I made a choice first to evaluate what I had in place and to determine if the process was working or to modify my curriculum. Then my choice was which course to focus on out of the many and which semester should I implement the changes?

**Gwen:** I made the decision to use valid reliable ways to assess. I chose only to focus on quality and implement this or not
**Harold:** To ignore or incorporate new knowledge because I’m not really evaluated on teaching – not held accountable. But no complaints could have ignored.

**Barbara:** I looked at things a bit differently. I was curious to know ‘where have my students struggled the most” and then choose to work on that.

**Frank:** Can I do CAT and QM at the same time? Are they complimentary or competing? I worked partly on CAT then QM then back to CAT so I didn’t really get to finish either.

**Evan:** What type of CAT for what type of course? Not just what type of assignment.

**Ann:** Which CAT to use for which instructional objectives or specific lessons? Am I choosing the right CAT based on the SLO action verb or behavior the student needs to demonstrate?

**Moderator:** Q4 (Epistemic volition-process) Describe the decision-making processes you used when choosing to adopt CATs?

**Barbara:** First I identified a need in a course, then I tried to identify which CAT would resolve the solution. I found that my stand alone course was easier to address because I had more autonomy to change the course, so I guess my next process was what is easiest?

**Carl:** My decisions were made based on the value or priority I gave to it. Is there value in this CAT? What is the value that it will add to my course?

**Gwen:** How urgent is it to make the changes? What would happen if I didn’t? then How feasibility is this CAT and do I have the time available to implement the CAT.

**Harold:** Which SLO is the easiest to start with and focus on then identifying the correct assessment tool.

**Moderator:** Q5 (Resolution strategies-reflection) describe how reflection on your old knowledge about classroom assessment influenced your decision-making about CATs?

**Evan:** I didn’t have a prior knowledge so I really did have much to reflect on.

**Frank:** For me, my department we rely upon certain questions on the final to measure outcome achievement. So I was forced to comply with something that was an established practice within the department. That created some concern and a political dynamic for me because there wasn’t much that I could change. But I wanted to accept the new concepts I was learning I just needed to figure out a way to be able to try and change the department philosophy.

**Moderator:** Q6 (Resolution strategies-participation) describe how participation in the CATs learning experience influenced your decision-making about CATs?

**Ann:** It made me more accountable to the students
**Moderator:** Can you explain that more?

**Ann:** I was looking at my syllabus, my assignments, the way I teach from a student perspective to see if it would make sense to them or be reasonable. It also made me think about how much or how little information I was giving them and how much information I needed to give to them so they could do things correctly and it would be easier for them. In the long run it would make it a lot easier on me because there would be less questions and less hours spent explaining things in class.

**Carl:** By participating it gave me the opportunity to hear how assessment was occurring in other areas other departments (all heads nod)

**Evan:** I think hearing other people in other departments and what they were doing helped to answer my questions and see things in a different way

**Frank:** I agree and think sharing information was really critical. It helped us, my group to work through problems we were having when we were completing the group assignments.

**Gwen:** Yes I agree it was that way for me too.

**Barbara:** Participating got me to work on a test that I had needed to work on for a long time but never took the time to do. I was able to get help from those in my group for real world patient scenarios and use it in my classroom as a patient case study component of my tests to add critical thinking elements. Workshop participation was functional and I could actually use the product I created.

**Donna:** Workshops gave me the initiative to look at assessment and implement course changes.

**Harold:** I think knowing the workshops was a series of three I had to carve out the time, and putting us in groups provided accountability to attend and participate in all workshops.

**Barbara:** Ha for some, look how many groups lost members that didn’t come back. For the last session we had to combine with another group to complete the last activity in class.

**Gwen:** Some in my cohort weren’t interested after the 1st workshop and didn’t come back. I think that may have impacted the rest of us in the group. I thought, “Why are they not interested?” It did affect me. I was concerned, mad, and frustrated.

**Harold:** Ya, but for me group accountability motivated me to do the work (all heads nod)

**Moderator:** Q7 (Resolution Strategies) describe the changes you made to your old classroom assessment methods through accommodation (replacing your existing classroom assessment methods with a CAT) or assimilation (modifying a CAT to fit your existing classroom assessment methods?)

**Moderator:** Accommodation- 4 Assimilation- 8
**Ann:** I didn’t know that there was a name for each of those things, but I guess it was assimilation that I did. Takes a lot of brain power to do accommodation or replace assignments.

**Barbara:** I did both I added the new CAT I created and then found that I had to modify other assignments because of the new assignment. What I mean by that is, I started using a grading rubric with the new lab assignment to add clarity to the lab assignments with different point allocations so I had to change the points allocated to the other assignments. Then because I used the rubric for formative instruction on the one assignment, I had to use it for all the other assignments.

**Evan:** I didn’t have enough time to create new assessment tools. There was so much in the curriculum that I needed to change. In the future I plan to make accommodations to make accommodations.

**Donna:** I think I would possibly create new assignments to replace some existing assignments in the Summer when I have more time to devote. If I was teaching a traditional class rather than online course accommodation might have been easier. But I can’t change things in the middle of the semester when its online.

**Moderator:** Q8 (Reciprocal causation- group interaction) how did working in collaborative groups influence the new knowledge about CATs and decision to adopt CATs?

**Frank:** I got to hear others ideas and then altered those ideas to fit my needs. I could ask them questions and those led to great conversations. Sometimes we got off track and needed to listen more to what we were supposed to be completing in the activity.

**Donna:** I think the groups were importing for scaffolding of learning. They created a structure for us to bounce ideas back and forth and test the ideas out especially if they were concepts that we had never worked with before. It took some of the fear of the unknown out of the equation and made it more likely for us to participate.

**Gwen:** I found that if I shared what I was doing it could help others. I talked about some of the things I had already done with assessment and some of the things that I still wanted to do. Sometimes I brought ideas to the group that others might not have considered. Like with my friend _____ I told her about the changes I made to my assignments and after the second workshop we got together and I showed her what I was doing. I helped her with creating a rubric for one of her assignments. So I think that there was an effect beyond the just the classroom.

**Carl:** I also found that I was more likely to use the item we were learning about if I could talk through it with my group members and get their perspective of how it could be used. They helped me work out the kinks. Kind of test drive the product before I implemented it in the classroom. I think that’s why I liked the peer review process. Having two other sets of eyes on what I created. At the same time that was kind of an intimidating process to have someone examine your thoughts.
Gwen: I can understand that. It makes you kind of vulnerable. Someone is looking at something that you worked really hard to create and you used your expertise. If they find a flaw or something then it’s a really hard blow if you take it the wrong way. In fact I think if you’re going to do peer reviews there should be some kind of peer review training to remind people that they can be critical in an encouraging way.

Moderator: Q9 (Reciprocal causation- group effect) how did change in your group member’s knowledge influence your learning about CATs?

Donna: I think it is inherent in teaching that when someone really "gets it" we experience a sense of joy for that person. Several of the faculty in my group really struggled with how they were going to get buy in and support from their department faculty. I feel like I helped them with this because our department has already embraced assessment and I could share how working together really was synergistic. So I think I helped my group more than how they helped me.

Ann: Many of the concepts were foreign to some faculty and they didn’t pick up on things easily. For me this was a struggle and I needed to be patient with faculty in my group that were a little slower in understanding or slower to be enthusiastic about the learning.

Carl: I was able to have smaller conversations within my group and I was able to see the culture of assessment start to change with some of my group members. Some were pretty resistant or complacent at first. Then there was a domino effect. I could see that everybody was starting to get on the same page and work together on figuring out how to match up activities with outcomes, selecting the right CAT with the right outcome and critical thinking tasks. I knew there was a major break through when we got ______ to admit that there was a benefit to using Bloom’s taxonomy. I think I actually heard him say Bloom’s.

Moderator: Q10 (Metacognition) how did the workshop series change the sophistication of your beliefs about assessment?

Ann: I think that I have become more articulate in my speaking with others about assessment but I still need to be a student of assessment.

Barbara: I think the way that I think and process how to convey to peers my offer of support and resources has become more sophisticated. There is an art to the sell of getting buy in. Before I would just tell my faculty to just do it. Now I can tell them to do it with reasons and a better background and understanding of the why, the purpose of why we are doing things and how it will benefit them.

Carl: Overall my understanding of assessment is broader and my beliefs are more grounded in the reality of what students should actually be doing. So I’m not sure if my beliefs are more sophisticated in the sense of more advanced. I think my beliefs have become more refined and clear about what assessment is and how I can use my knowledge.

Harold: I think of sophistication as a sense of empowerment to change. To be in control of
change. I think that I have done that by creating and adding real world skill activities to my courses.

**Donna:** I think that my beliefs and thought processes have become more sophisticated because I have higher expectations. I can discern that some assessment reports that I read when they are sent to me for approval are not genuine. It was easier for me to buy into or adopt the concept of CATs because I wanted to be genuine in my own assessment processes and a genuine instructor that students could learn from.

**Gwen:** I’ll tell you how this made my beliefs a lot more sophisticated. This experience made be think about learning in general and I found myself transferring what I learned beyond education at the college to my children’s education. At parent teacher conference I grilled the instructor on how she knew my child was learning and how she knew that the homework was really providing them true practice rather than just busy work. I think she totally wasn’t expecting that. But what it made me realize is I’m not sure she had ever had any training like this in her education degree. These are concepts that all teachers should know whether you teach adults or children. My beliefs about assessment have become more sophisticated in the way that now I am more critical of the system and maybe now I can be more of an advocate to change things.
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CURRICULUM VITAE

Sharon G Peterson, RDH, M.Ed.
Doctoral Candidate
Department of Educational Psychology
College of Education
University of Nevada, Las Vegas
peterss1@unlv.nevada.edu

EDUCATION

University of Nevada Las Vegas, Las Vegas, Nevada
Doctor of Philosophy: Education Psychology, May 2018
Master of Education: Educational Leadership, May 1999

Idaho State University, Pocatello, Idaho
Bachelor of Science: Dental Hygiene, May 1988

ADMINISTRATIVE EXPERIENCE

2015- Current  Director- Office of Assessment and Accreditation
College of Southern Nevada

Responsibilities:
Oversight and management the institution-wide system for documenting assessment of student
learning, program evaluation, and strategic plan indicator
Management of institution transfer articulation agreements and memorandum of understandings
for higher education stakeholders
Delivery and oversight of professional development in teaching and assessment methodology
Evidence management and annual reporting for regional and specialized accreditation agencies

2013- 2015  Assessment Coordinator- Engelstad School of Health Sciences
College of Southern Nevada

Responsibilities:
Oversight and approval of department assessment plans and reports.
Documentation support for the Office of Assessment & Accreditation
Committee data manager for regional accreditation reporting of the Northwest Commission of
Colleges and Universities.
Faculty development

2008-2014  Program Director- Associate & Bachelor Dental Hygiene Degree Programs
College of Southern Nevada

Responsibilities:
Fiscal management of program and clinic budgets, faculty and staff scheduling, supervision, and
evaluation; curriculum development, management, and evaluation; program evaluation,
competency and student learning outcomes assessment; annual and self-study specialty accreditation reporting.

TEACHING EXPERIENCE

1997 - present  College of Southern Nevada  
Tenured Professor- Associate and Baccalaureate Dental Hygiene Programs

2007 - 2016 University of Nevada Las Vegas  
Volunteer Instructor- School of Dental Medicine – Periodontal Instrumentation

2006 - 2008 Dixie State College  
Instructor - Associate and Baccalaureate Dental Hygiene Programs  
Consultant - Curriculum Development and Accreditation Specialist

1990-1992 Idaho State University  
Part-time Instructor- Baccalaureate Dental Hygiene Program

ACADEMIC AND PROFESSIONAL RESEARCH


PROFESSIONAL PUBLICATIONS


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**PROFESSIONAL ASSOCIATIONS/MEMBERSHIPS**

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Professional references available upon request