5-2015

Adoption, Adaptation, and Abandonment: Appropriation of Science Education Professional Development Learning

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ADOPTION, ADAPTATION, AND ABANDONMENT: APPROPRIATION OF SCIENCE EDUCATION PROFESSIONAL DEVELOPMENT LEARNING

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Education

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UTAH STATE UNIVERSITY
Logan, Utah

2015

ABSTRACT

Adoption, Adaptation, or Abandonment: Appropriation of Science Education Professional Development Learning

by

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Utah State University, 2015

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Understanding factors that impact teacher utilization of learning from professional development is critical in order maximize the educational and financial investment in teacher professional learning. This study used a multicase mixed quantitative and qualitative methodology to investigate the factors that influence teacher adoption, adaption, or abandonment of learning from science teacher professional development. The theoretical framework of activity theory was identified as a useful way to investigate the phenomenon of teacher appropriation of pedagogical practices from professional development. This framework has the capacity to account for a multitude of elements in the context of a learning experience. In this study educational appropriation is understood through a continuum of how an educator acquires and implements both practical and conceptual aspects of learning from professional development within localized context. The variability associated with instructional changes made from professional

development drives this inquiry to search for better understandings of the appropriation of pedagogical practices. Purposeful sampling was used to identify two participants from a group of eighth-grade science teachers engaged in professional development designed to investigate how cyber-enabled technologies might enhance instruction and learning in integrated science classrooms. The data from this investigation add to the literature of appropriation of instructional practices by connecting eight factors that influence conceptual and practical tools with the development of ownership of pedagogical practices in the appropriation hierarchy. Recommendations are shared with professional development developers, providers, and participants in anticipation that future science teaching experiences might be informed by findings from this study.

(157 pages)

PUBLIC ABSTRACT

Adoption, Adaptation, or Abandonment: Appropriation of Science Education Professional Development Learning

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Understanding factors that influence teachers to use certain practices from training they receive will help improve learning experiences for students. This study examined how two teachers with the same teacher training experience use learning from that training in their instruction differently. This research attempted to account for multiple factors that influenced teachers learning. Educator's incorporation of teaching practices can vary from teacher to teacher and from training to training. This variability is understood in terms of their appropriation of new teaching practices into their teaching and delivery of learning. Two teachers were selected as a result of their participation in an eighth-grade science teacher training session where they exhibited unique characteristics that could inform this study. Information was collected from these teachers through classroom observations and individual interviews. This study looked at connecting the practice of educators and the factors that influence change in their teaching practice. The study provides eight factors that influence how a teacher uses new

ideas and practices from training experiences, and how those in charge of the training can improve classroom implementation outcomes.

ACKNOWLEDGMENTS

The completion of a doctoral dissertation is personally gratifying; however, as I reflect on the process I recognize that numerous individuals have been amazing influences for me throughout this journey. I simply acknowledge that this has been much more than my personal achievement. I will be eternally grateful to my family, friends, and colleagues who have supported and encouraged me throughout my career. I wish to express my gratitude to these individuals and share any accolades for this accomplishment with them.

I express my gratitude to my major professor, Dr. Suzanne H. Jones, for her assistance in providing essential direction, guidance, and encouragement throughout this process. I also express my appreciation to Dr. Todd Campbell for his friendship, mentoring, and constant positive encouragement in seeking and obtaining a doctoral degree. I am grateful to a supportive committee who invested time, thought, and advice during my research. I also express my appreciation to my colleagues at Utah State University who have treated me as a peer before a student. I am grateful to my colleagues throughout Utah for their ongoing efforts to support, challenge, and believe in my abilities. All of these individuals have influenced my growth as a professional.

I express appreciation to the educators who participated in the Cyber-Enabled Learning Project, and specifically to Bonnie and Renee, who allowed me into their classrooms, thoughts, and homes. Without their willingness to allow me into their educational world I would not have been able to learn and see new ways of improving education. I also express appreciation to the National Science Foundation for supporting

this research in part through a Discover Research K-12 Project (Award #1020086) granted to Dr. Todd Campbell, Principal Investigator.

I am tremendously grateful to my parents, Robert and Nola, for instilling in me a desire and perseverance to accomplish worthwhile goals and a belief that I can make a difference. I express gratitude to my brothers for helping me learn the importance of hard work and the value of family. I am grateful to my wife's parents, Lyle and Pat, and her family for their encouragement and support of my family and me.

Without the support and encouragement of my wonderful children, Kayla, Sydney, and Page, I would not have been able to complete this goal. Many nights while I studied and they slept I wondered if my time away from them was worth the sacrifice. I love them for who they are and who they have the potential to be. Their patience and sacrifice of time with their papa is a gift I can only attempt to repay.

The influence of my wife, Shana, on my life exceeds my ability to express in words. She has sacrificed numerous personal desires to allow me to grow professionally. She has always been and will always be the greatest teacher in our home. She has supported me in word and action and I am sure I will never be able to recognize the countless acts that she does for me, and without my recognition. I will always be truly grateful for her friendship, encouragement, love, and faith in me.

Finally, I am grateful to acknowledge a loving Heavenly Father who has given me the gifts of family, friends, and colleagues that fulfill my life.

Max L. Longhurst

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CHAPTER I

INTRODUCTION

Science teaching practices currently exhibited in many of our nation's classrooms are being reevaluated in light of documents from the National Research Council (2012) such as "A Framework for K-12 Science Education" and the Next Generation Science Standards (NGSS, 2013) in order to produce reformed classroom practices and intended instructional and student achievement outcomes (Visio, Ross, & Adams, 2008). Additionally, systemic change projects supported by the National Science Foundation (NSF) have been developed with the intent of improving science teachers' content knowledge and skill at providing reformed science teaching (Shymansky, Wang, Annetta, Yore, & Everett, 2012). This transformed vision for professional development (PD) requires teacher learners to experience both reformed practices and conceptual reconfiguration of the underpinnings of those practices in order to rethink current practices (Grossman, Smagorinsky, & Valencia, 1999; Shymansky, Wang, Annetta, Yore, & Everett, 2013; Visio et al., 2008). This reformed vision of PD should include a consideration of professional learning characterized by long term experiences that enhance instructional practice through the creation of opportunities to re-conceptualize instruction (Shymansky et al., 2012, 2013). However, the reality of providing PD and professional learning is that administrators, policy makers, parents, and funding agencies require evidence of enhanced student learning in connection with the activities (Shymansky et al., 2013). Professional learning of science teaching is at a crossroads where the essential design features of PD must be informed with an understanding of how

teachers appropriate practices that positively impact student learning (Visio et al., 2008).

The underlying premise of PD is that as teachers are better prepared this will translate to improved instructional delivery resulting in increased student learning outcomes (Banilower, Heck, & Weiss, 2007). In fact, this link between what a teacher does and what a student learns has been the purpose for all formal and informal programs of teacher education both preservice and in-service (Shymansky et al., 2012). The increasing emphasis on instructional reform continues to drive a need to realize the potential of PD.

Over the last three decades, research in and on PD elements has produced numerous lists of key features that are remarkably similar; however as Banilower and colleagues (2007) indicated, the empirical evidence for these key features is limited. Despite the identification of these key elements, currently practicing teachers are not being engaged in experiences that align with these elements (Borko, 2004). The dilemma of gathering evidence for educational researchers is compounded by the limited implementation of effective measures due to local policy restraints, misunderstandings and misinterpretations of best practices, community traditions of practice, and others factors (Borko, 2004). Yet, PD remains the central vehicle to align practice with the vision of national reform efforts and, therefore, should continue to be an emphasis for researchers and practitioners even with the current utilization challenges (Banilower et al., 2007; Hill, Beisiegel, & Jacob, 2013; Penuel, Fishman, Yamaguchi, & Gallagher, 2007).

This research study investigated eighth-grade science teachers' appropriation of

learning from PD within an NSF Discovery Research K-12 (DRK-12) grant. In the NSF project, differences in student achievement data were observed when comparing the intervention group (science teachers participating in PD) with the control group (science teachers not participating in PD; Campbell, Longhurst, Wang, Hsu, & Coster, 2014a). Higher student achievement gains in science were associated with teachers who participated in the project PD when compared with student achievement in science with teachers who did not participate in the project PD. In this study, a quantitative analysis of data was used to identify teacher participants whose students exhibited learning gains paired with a qualitative investigation of the factors that influenced teacher participant's adoption, adaptation, and abandonment of principles and practices from the PD process. The qualitative aspect included observations paired with semistructured interviews using anchors identified during observation sessions. This mixed method approach connected the perceived outcome of increased student achievement, a concern of the entire educational community, with a focus on a rich case analysis informing educators of influential factors of PD appropriation.

Significance of Problem

Educational researchers are challenged to understand why teachers implement new pedagogical practices from PD opportunities with extreme variability. In multiple settings science teachers have been observed adopting, adapting, or regularly discarding both conceptual and instructional practices specifically targeted by PD providers (Ebert-May et al., 2011; Fung & Chow, 2002). PD that instructs teachers how to use proven

teaching strategies, practices, and even possesses effective curriculum has not been enough to ensure classroom implementation (Ebert-May et al., 2011; Shymansky et al., 2013). Developing an effective curriculum is merely one aspect to improvement of educational practice. Educators, researchers, and PD providers continue to search to understand elements that influence the implementation and enactment practices of teachers participating in professional learning. The unjustifiable persistence of traditional PD techniques and strategies should not continue to occur. This research seeks to provide data informing the educational community about influential factors that persist within the context of traditional PD efforts.

Traditional curricular reform efforts have been viewed as effective when teachers dutifully implement the ideas of others (van Driel, Beijaard, & Verloop, 2001). van Driel and colleagues (2001) provided a basic explanation of traditional PD practices described below.

- Core elements of the curriculum defined by developers or administrators.
- Descriptive expectations of teaching behaviors aligned to the innovation were provided.
- Training sessions aimed at the innovative practice were provided. Usually this consisted of single session workshops.
- Normally the innovative practices were not adopted by participating teachers resulting in behaviors that did not persist within the classroom.
- The previous four steps were repeated after modification or redefining of the innovation occurred (van Driel et al., 2001).

The lack of utility for this traditional method of PD has been apparent, yet this type of learning experience continues to be provided to teachers (Ball & Cohen, 1999; Borko, 2004). In the past, teacher development focused on specific instructional behaviors that were connected to student achievement scores. The assumption was that if teachers acted in specified ways students would learn. This notion has given way to developing teachers' practical knowledge or craft knowledge (van Driel et al., 2001). Craft knowledge can be understood in terms of knowledge *"of"* practice, which is generative knowledge obtained through teaching and learning versus previous efforts to develop a knowledge *"for"* practice that established external experts as those trusted with generating instructional knowledge (Visio et al., 2008). Researchers and educators must find effective practical methods of implementation in order to bridge the gap between research and practice as our knowledge of the elements of effective professional learning increases.

Theoretical Framework of Investigation

Over the last 20 years the educational community has learned a great deal about the development practices employed and effects attributed to teacher training practices (Shymansky et al., 2012). Discussions regarding the number of hours needed to implement instructional programs, effects of PD on student achievement, and participation levels influencing motivation for implementation have all contributed to a greater understanding of PD (Luft, 2001; Penuel & Gallagher, 2009; Shymansky et al., 2012). Although our knowledge of teacher learning is expanding, additional empirical

evidence and investigation is still needed (Banilower et al., 2007). Challenges in this effort stem from multiple factors that appear to influence PD experiences and the social contexts that mediate individual implementation (Bourke, Mentis, & O'Neill, 2013).

Along with other researchers, I see value in utilizing a theoretical framework grounded in activity theory as a means of elucidating the multiple factors that influence how teachers appropriate pedagogical principles and practices (Bakhurst, 2009; Bourke et al., 2013; Glaser & Strauss, 1967; Grossman et al., 1999; Jonassen & Rohrer-Murphy, 1999; Yamagata-Lynch, & Haudenschild, 2006). A multitude of nuanced understandings that surround activity theory have given rise to various theoretical frameworks being used to research sociocultural and contextual phenomena. The operational understanding of activity theory used in this research was that a teacher's application of conceptual pedagogy and implementation of practical strategies are both influenced by contextual social and cultural factors that can be understood through observation of outward actions connected to personal dialogue (Grossman et al., 1999; Roth & Lee, 2007). In this study, activity theory allowed for the collection of rich data that provided depth of understanding for the diverse influences present in the teaching and learning environment (Nussbaumer, 2012). In the literature review section, I provide a historical description of activity theory, followed by a more detailed look at appropriation and how I utilized this element of activity theory as a heuristic for PD implementation. This discussion will provide an understanding of the value of using activity theory as a framework for investigating professional learning of educators.

Rationale for Investigation

As described by Rogers and colleagues (2007), enactment of PD seldom occurs with strict adherence to the intended outcomes of the activity. Creating the right fit, experiencing PD as a learner, and facilitating the mediation of conceptual and practical tools are all integral in the current literature for effective teacher development (Grossman et al., 1999; Penuel & Gallagher, 2009; Penuel & Means, 2004; Shymansky et al., 2012). Some have found that ownership of instructional practice is profoundly influenced by the opportunity to make localized modification to teaching modules resulting in acceptable changes to the essential aspects of practice. However, at times unacceptable, changes or "lethal mutations" (Davis & Krajcik, 2005) to practice can develop if learners engage in open-ended experiences (Penuel & Gallagher, 2009).

Acceptable curricular adaptations may be an integral part to increased effectiveness of PD delivery because they allow participants to invest in the effective implementation of cooperatively created instruction. Further study regarding the acceptance and intended space created for localized adaptation may enable researchers to identify ways to build greater capacity to implement conceptual strategies with content beyond that which is targeted in the PD. The creation of collaborative cultures also seems to be a constant element in PD discussions, yet the actualization of building a community can be elusive and warrants further investigation. These aspects combined with other factors provide a clear purpose for investigating how teachers appropriate new concepts and practices gained through participation in PD experiences.

Research Questions

This research informs both the science education community and, in a broader sense, those funding, developing, and implementing teacher learning experiences. Although research has been conducted to date providing insight regarding general principles of PD programs, the empirical evidence supporting specific practices within professional learning is limited (Banilower et al., 2007; Brand & Moore, 2011; Guskey, 2003). Currently, several models using a constructivist and sociocultural theory, specifically *activity theory*, are emerging that provide researchers with a promising theoretical framework for understanding and interpreting the cultural and contextual interactions evident in the professional learning of science educators (Bourke et al., 2013; Brand & Moore, 2011; Feryok, 2012; Grossman et al., 1999; Margolis & Doring, 2012; Valencia, Place, Martin, & Grossman, 2006). The limited number of studies in this area that target science education suggest the need for continued investigation (Fogleman, McNeill, & Krajcik, 2011; Forbes, 2013; Penuel & Gallagher, 2009; Van Duzor, 2011).

In this study, I used the five degrees of appropriation (Grossman et al., 1999) in combination with the dimensions of practical and conceptual pedagogical tools to understand how teachers appropriate new practices and ideas (Hardy, 2013; Rogers et al., 2010). The five degrees of appropriation provided a frame for understanding how teachers are influenced by multiple factors to adapt and adopt pedagogical practices. The five degrees of appropriation introduced by Grossman and colleagues are: (a) lack of appropriation, (b) appropriating a label, (c) appropriating surface features, (d) appropriating conceptual underpinnings, and (e) achieving mastery. These five degrees of

appropriation provide an enactment continuum for investigating the factors that influence implementation of practices from PD.

Intentionally targeting participating teachers through a quantitative approach enabled the qualitative data collection to have a purposeful approach. This mixed method research initially used quantitative data follow by a strong focus on qualitative methodology to gather rich information that would ultimately inform the following research questions.

For participating science teachers whose students demonstrate increased achievement when compared to students of nonparticipating teachers:

1. How and to what extent are teachers influenced to appropriate pedagogical tools from professional development?

2. What role do conceptual and practical pedagogical tools play in the appropriation of instruction strategies associated with professional development?

I predicted that, on state science achievement measures, students of teachers who have participated in the 2-year PD (Cyber-Enabled Learning project) would outperform students with teachers who did not participate. I also anticipated that enactment practices occurring within the classroom would be influenced by numerous factors and through the use of an activity theory framework I would be able to identify and better understand the phenomena of teacher implementation of principles and practices provided in PD (Bourke et al., 2013). Preliminary data from a pilot study provided evidence suggesting that individual teachers vacillated between a need for conceptual and practical tool utilization to increase appropriation levels (Longhurst, Jones, & Campbell, 2015).

Summary of Methodology

This examination of teacher appropriation of conceptual and practical pedagogical tools was situated within the context of a NSF professional development project in the Western United States. A purposeful sampling technique was the first step in a mixed methodological instrumental case study design to illuminate a theoretical explanation of PD appropriation (Christensen, Johnson, & Turner, 2011; Merriam, 2009; Spradley, 1980). This design allowed me to identify optimal student learning outcomes followed by investigation to understand contributing components of increased achievement.

The design followed a sequential order, initiated with quantitative data analysis followed by qualitative data collection and analysis (quan → QUAL), intended to aid in understanding the phenomena (Christensen et al., 2011). Quantitative data from a current cohort of the Cyber-Enabled Learning Project (Campbell, Zuwallack, Longhurst, Shelton, & Wolf, 2014b) was analyzed in order to identify variations in student achievement. Descriptive analyses and cluster analyses were conducted to inform a purposeful selection of teacher participants with student achievement gains statistically different from control populations (Creswell & Clark, 2007). Additional discriminate analysis and qualitative selection was necessary to identify the two participating teachers.

Once study teachers were identified, qualitative methods were used to gather data. Classroom observations were conducted that informed one-on-one interviews with anchored activities informing question selection. In response to Margolis and Doring's (2012) call, this study design enabled researchers to investigate teacher appropriation at a fine-grained level providing valuable data that could inform PD providers.

Researcher Positionality

As both a researcher and teacher, my positional lens was informed from a theoretical stance and the reality and utility of practice. During my educational career, I have engaged in numerous PD experiences as a participant, provider, and developer. In these roles I have observed a variety of reactions to innovative ideas and techniques. As a general rule I have personally found PD experiences, both as a participant and a provider, to be positive. This may be as a result of much of my work being conducted with elementary educators who were generally supportive of the PD sessions.

Observing the wide array of implementation from PD has been challenging personally, yet this also had driven my search to understand the phenomena of appropriating pedagogical principles and practices. In this study I served as both the investigator and PD provider, which created a uniquely embedded vantage point as a researcher. This vision of the PD enabled me to view the participant appropriation from an informed stance that external evaluators would have been unable to employ.

Limitations

The qualitative nature and small number of participants identified for this study created limitations on the generalizability of findings for this research; however, the same small number of participants strengthened the depth and richness of the investigation through the collection of thick description of classroom practice (Merriam, 2009; Spradley, 1980). Multiple personal observations and interviews enabled me to develop a trusting environment where participating teachers openly shared developing ideas,

unrehearsed thoughts, and questions about appropriation of conceptual and practical pedagogical tools.

Having been both a provider and developer of the PD included to the NSF-funded DRK-12 grant, in which this investigation is situated, allowed for a connectedness with the content, delivery, and participants that enabled me to access concepts that may have been overlooked by an external investigator. My connected relationship to the participants and the project also created a concern that participants would 'search for the right' answer during interview sessions, in an effort to meet my expectations. Multiple paired observation/interviews with connected anchors to classroom practice were intended to minimize the concern of participants searching for the 'right' answer.

Organization

This dissertation provides a background discussion of activity theory and how this theoretical frame can inform the investigation of PD appropriation. The literature review includes historical aspects of professional learning and current knowledge of how PD is incorporated into classroom instruction. Following the literature review, a description of the methodology of this investigation is provided. The rationale for the investigation, research design, participants, data collection, procedure, validity concerns, and data analysis and conclusions follow this introduction.

Operational Definitions of Terms

In order for readers to gain an understanding of the nuanced terminology used in

this dissertation, the following words and phrases have been operationally defined. I have presented them in an order that builds on a readers' background knowledge and understanding instead of alphabetically.

Professional development (PD)—is understood as teacher-learning experiences that are intended to inform enhancements to classroom practice and teaching pedagogy. PD has been commonly used to describe the traditional workshop style delivery of teacher learning experiences. For this study PD refers to the experience that a teacher engages in to improve instructional ability and knowledge.

Professional learning—is considered here to encompass daily and ongoing experiences of professional educators in an effort to enhance instructional practices and includes both the practical "for" teaching techniques and the conceptual or principles "of" instruction. PD is considered a single event or activity while professional learning is understood to be a long-term sequence and approach to teacher growth.

Activity theory—is a sociocultural theoretical framework that provides a lens for recognizing and perceiving the factors that influence the appropriation of pedagogical practices and principles. Within activity theory multiple sociocultural factors are identified that influence a learning outcome. In this study conceptual and practical tools are targeted to understand their influence on the appropriation of pedagogical concepts and practices (Bourke et al., 2013; Brand & Moore, 2011; Feryok, 2012; Grossman et al., 1999; Margolis & Doring, 2012; Valencia et al., 2006).

Appropriation—is described in terms of adoption, adaptation, and abandonment of both pedagogical practice and conceptual understanding (Davis & Krajcik, 2005;

Penuel & Gallagher, 2009). In this study, educational appropriation is understood as a continuum of how an educator acquires and implements both practical and conceptual aspects of learning from PD within localized context (Grossman et al., 1999). Appropriation of pedagogical practices and concepts is much broader than implementation with a scripted fidelity to the teaching for science learning (Forbes, 2013). Practically, appropriation includes acceptable modification that improves the delivery and reception for learners.

Adoption—occurs as individuals comply with the instructional delivery methods of a curricular program. Adoption of a technique, practice, or activity can be characterized as dutifully following the steps provided by the developer of the practice(s), and is exemplified by traditional curricular reform efforts described by van Driel and colleagues (2001).

Adaptation—includes adoption components, yet allows for a teacher-learner to make acceptable modifications of the practice(s) ultimately enhancing the practice(s) or principles for successful implementation in a local context (Shymansky et al., 2013). PD developers might view adaptation as implementation occurring that is consistent with the intent and aims of the professional learning but has nuanced changes that improve the delivery or reception of the teaching and learning practice(s) (Century, Rudnick, & Freeman, 2010; Rogers et al., 2007).

Abandonment—consists of teacher-learners who discard new ideas and practices shared within the context of PD (Grossman et al., 1999). Required attendance, personal or family concerns, location, provider characteristics, and other influences can be the

components that cause abandonment to occur.

Conceptual tool(s)—are informed pedagogical principles that influence and give purpose to specific instructional practices (Hardy, 2013; Rogers et al., 2010). An example would be the purpose for students to develop a researchable question within a science classroom. The purpose informs the manner in which the instructor develops the student understanding but is separate from the specific instructional sequence or materials. Bakhurst as well as Asghar identified conceptual tools as key influences within the activity theory framework, which had previously been defined by Vygotsky (1987) as mediating artifacts (Asghar, 2013; Bakhurst, 2009).

Practical tool(s)—are the applied techniques, strategies, or activities of instruction (Hardy, 2013; Rogers et al., 2010; Yamagata-Lynch & Haudenschild, 2006). An example could be the specific probe and the process of how to use the probe for a given lab experiment. Without a conceptual understanding, practical tool implementation may be limited to following a plan or using a particular instrument.

Mediation—is exemplified by reciprocal and constant adjustment of the context and the learning (Nussbaumer, 2012). The process of appropriation is iterative where the local and historical context as well as the individual learning seem to influence each other, creating an understanding of both that is constantly being adjusted (Engeström, 2001). Both conceptual and practical tools are mediated by each other and the context of the learning.

CHAPTER II

REVIEW OF RELATED LITERATURE

Determining the implementation and effect of teachers who engage in PD is critical when one considers our current standards-based education reforms and the financial investment in supporting these reforms. Sawchuk (2010) indicated that urban districts do not realize the amount of funding spent on PD within the teaching cadre. It is estimated that this allocation is between $6,000 and $8,000 per teacher for each school year. Interest in the impact of professional learning is not limited to financial considerations; the enactment of professional learning vacillates between extreme scripted adherence to unrestrained adaptation or even to complete abandonment (Rogers et al., 2007). The goals of policy makers, PD providers, and participating teachers should center on what a teacher does in connection to what a student learns (Shymansky et al., 2012). This investigational study begins with identifying student learning gains and is intended to link the influences of what a teacher does to achievement gains.

Historical Foundations of Activity Theory

Educational researchers identify and recognize the importance of social aspects of teaching and learning (Bourke et al., 2013). This sociocultural view of learning was initiated through the work of Vygotsky (1987), a Russian developmental psychologist. In his work, Vygotsky (1978, 1987) saw value in the use of tools, both cognitive and physical, to move society forward in productive ways (Jonassen & Rohrer-Murphy, 1999; Ormrod, 2012). Much of Vygotsky (1987) and Luria's, a contemporary colleague, work

was focused on the environment or context of a learner's experience (Luria, 1976). Lazarou (2011) discussed a deviation from the stimulus-response process that was the predominant thinking of Vygotsky's time (Lazarou, 2011). Vygotsky (1987) saw this explanation of stimulus response as limited in the explanation of complex cognitive responses of individuals. Feryok (2012) suggested that human action is mediated by a tool in the form of cognition or practice (Jonassen & Rohrer-Murphy, 1999; Lazarou, 2011; Nussbaumer, 2012). Activity theory is a product of this sociocultural view of learning and provides a philosophical framework for investigating developmental processes (Jonassen & Rohrer-Murphy, 1999).

Recognition of sociocultural influences of professional learning through the use of activity theory has the capacity to enable researchers to illuminate rich descriptions of how individuals interact within a context to develop a personal belief or motive for action (Grossman et al., 1999). It appears that beliefs and motivations about learning and learners ultimately influence teacher action and practice (Nussbaumer, 2012). The use of activity theory to understand PD enables researchers to identify the numerous factors that influence actions, motives, and beliefs have the potential to inform a more complete understanding the implementation of instructional practice. For example, a teacher may return from a PD experience desiring to implement a unique questioning strategy within her science classroom; however, upon return to the school context, colleagues question the practice resulting in a decreased motivation to implement.

The development of the activity theory framework originated with Vygotsky's (1978) and Luria's work in the 1920s, which was based on the idea that human cognition

is developed through cultural or contextual experiences creating unique and individualized learning opportunities (Jonassen & Rohrer-Murphy, 1999; Smagorinsky, Cook, Jackson, Fry, & Moore, 2004).

Jonassen and Rohrer-Murphy (1999) described activity theory as a "philosophical framework" that provides a helpful lens to investigate teacher learning, rather than an investigational methodology (p. 62). In their study, Jonassen nd Rohrer-Murphy designed an analysis of activity units described as constructivist learning environments (CLEs). This method of analysis focused on a practice and was used as a descriptive measure rather than prescriptive (Jonassen & Rohrer-Murphy, 1999). This process of descriptive analysis necessitates the use of a qualitative approach for my current research.

The activity theory framework posits that through experience of an activity, conscious thought or learning is developed. By understanding learning through a sociocultural and socio-historical lens we can analyze the impact of teacher-learning experiences in the context of conscious construction of pedagogical practices (Bakhurst, 2009; Jonassen & Rohrer-Murphy, 1999). Bakhurst described activity theory as a lens to look at a particular phenomenon. The use of qualitative measures is helpful since a phenomenon, or educational activity in this instance, is part of a complex system. The descriptive capacity of this framework is effective in various settings including educational contexts (Bakhurst, 2009).

Vygotsky (1987) deviated from the notion of stimulus-response impacts on behavior, the norm at the time, to a new approach introducing the "triangular model" of action. In this model a mediating artifact was introduced that was necessary to understand

how an individual or society might be prompted or have action modulated instead of simply having a stimulus and then a response as in behaviorism (Bakhurst, 2009; Bourke et al., 2013; Engeström, 2001; Jonassen & Rohrer-Murphy, 1999; Nussbaumer, 2012). A mediating artifact is best understood by viewing learning through "…our contact with the world…" (Nussbaumer, 2012; Wertsch, 1991, p. 179). An example of a mediated artifact could include a teacher's understanding of 3-Dimensional science instruction through a collaborative peer discussion. Mediation occurs when both peers' understanding of the three dimensions are modified and improved upon as a result of the discourse.

Vygotsky (1987) and Luria's (1976) work is considered the *first generation* (Figure 1) of activity theory. This first generation of activity theory proposes that learning or development is dependent on how learners, adults or children, interact with and share cultural tools (Asghar, 2013; Bakhurst, 2009; Lazarou, 2011). First generation activity theory can be understood as learner development being dependent on the interaction and sharing of cultural goals. Vygotsky often shared the example of tying a knot in a handkerchief as to remind the learner of a task. The knot creates an interaction with the learners' development to achieve the intended goals.

The three elements of their model include the subject, object, and tools or artifacts. Operationally, a teacher provides an experience, such as a group project to

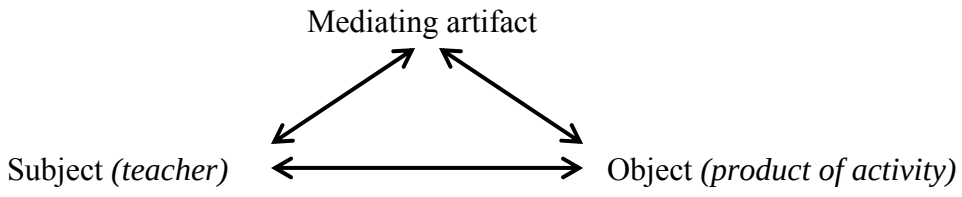

Figure 1. First generation activity theory.

describe causes for the seasons on Earth allowing learners to investigate in a situated learning activity. The *subject* can be described as the participants of an activity that are motivated toward an object or purposeful action. The *object* (understanding of the seasons) is referred to as the goal of an activity, which may include acquiring motivation to participate in an activity. The third element is that of *tools*, which can be internal or external and are often exhibited as psychological and/or material tools (Asghar, 2013; Yamagata-Lynch & Haudenschild, 2006).

A *second generation* model of activity theory (Figure 2) was developed by a student of Vygotsky, Alexei Leont'ev (1981), who differentiated between *action* and *activity*, articulating that actions are performed by individuals or groups while activity involves a community and has an object and motive. To illustrate, Bakhurst (2009) shared an example of a beater who startles wild game and then allows other individuals to catch the animal in a hunter-gatherer community. Leont'ev described the *action* of this individual as beating the bush; his *activity* is hunting along with the rest of his community. This example illustrates that the actions of an individual are influenced by how that action contributes to a broader social activity. Searching for factors that influence appropriation of pedagogical practices is informed by understanding these

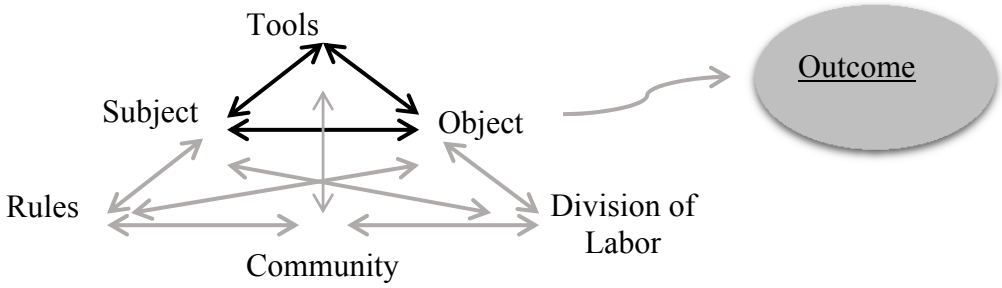

Figure 2. Second generation activity theory.

factors that influence action. If, as researchers, we can identify actions that influence acceptable use of learning in PD we may be able to support these actions by PD providers.

It should also be noted that social activity is influenced by individual actions creating a multidirectional influence or mediation of actions and activity. In second generation activity theory, human cognition can be influenced by others, interactions with the context, and social rules (Asghar, 2013). Leont'ev (1981) added to Vygotsky's model with the inclusion of *rules*—including compliance with the regulatory frameworks of an institution, *community*—how individuals interact within a group, and *divisions of labor*—which dictates how individuals work together and includes power and status (Asghar, 2013; Bakhurst, 2009; Roth & Lee, 2007). Within science education there are numerous divisions that influence a teacher's use of pedagogical practices including district administration, the principal, department chair, or departmental peers. Therefore, using a theoretical framework that accounts for multiple influential factors is beneficial (Nussbaumer, 2012; Yamagata-Lynch & Haudenschild, 2006). The inclusion of these elements within activity theory provide opportunity to account for inter-relationships within the first generation elements and between the second generation elements of rules, community, and division of labor.

The *third generation* (Figure 3) of activity theory examines the interaction of multiple activity systems and is beneficial when considering the numerous networks that educators operate within on a daily basis (Engeström, 2001; Nussbaumer, 2012). Sub-networks within education contribute to and mediate the implementation of PD learning.

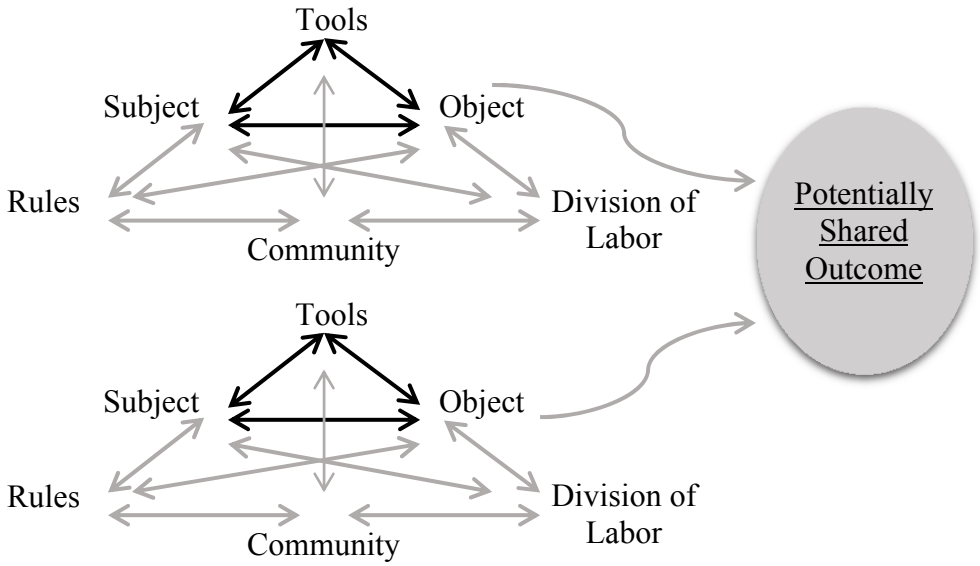

Figure 3. Third generation activity theory.

A previous example described teachers engaging in a collaborative peer discussion about 3-Dimensional science instruction. Following the return from a 3-day PD session, a novice teacher finds that peers within the school attended a similar experience 2 years earlier. This prior knowledge and application now interacts with the novice teacher's ability to enact their perception of the session as a result of their peer's disposition.

Bakhurst (2009) credited Yrjo Engeström for continuing the development of activity theory into this third generation, characterized by collective learning through change. This generation of activity theory encourages and illuminates networks of activity systems that influence and contribute to potentially shared outcomes.

As in our previous example regarding the cause of seasonal change multiple factors may affect student understandings, a particular learner's experience with seasonal

change and interaction with other activity groups will impact the learning results. If an individual has been lead to believe that the seasons are caused by proximity to the sun based on textbook illustrations the outcome of the group discussion may contain misconceptions of seasonal change. In the third generation, multiple "activity systems" influence the learning outcome(s); however, within all the generations of activity theory the top triangle continues as the investigational focus (Jonassen & Rohrer-Murphy, 1999). It is important to recognize that elements of multiple activity systems are continually mediated (impacted and influenced) by each other (Nussbaumer, 2012). Understanding the range of the influential factors upon an educational outcome enables researchers to account for greater variation of teacher appropriation efforts.

Appropriation

PD providers should consider how opportunities for teachers to enact new practices promote current reform efforts (Schneider, Krajcik, & Blumenfeld, 2005). Two key products of research initiated investigations into appropriation of professional learning. Program integrity was discussed by Dane and Schneider (1998) where the degree to which a program's purpose was replicated by those who participated in the PD experience. Specifically, their study investigated the extent of the inconsistencies of fidelity in relation to the program delivery within reviewed studies published between 1980 and 1994 (Dane & Schneider, 1998). This seminal study brought the fidelity versus adaptation debate to the forefront of educational research (Dane & Schneider, 1998). Subsequent discussions have focused on fidelity of implementation measures and varying

perspectives on appropriation (Century et al., 2010; Grossman et al., 1999).

Grossman and her colleagues provide a clear understanding of how aspects of activity theory including appropriation focus on the social and cultural factors that mediate learning in educational contexts (Grossman et al., 1999). Appropriation research provides a better understanding of how educators adopt and adapt *conceptual* and *practical* tools gained through professional learning (Hardy, 2013; Rogers et al., 2010). One tool in particular that has been studied is the orientations to science. In the study conducted by Rogers and colleagues, nine PD projects were evaluated according to their exhibited orientations, which align to this appropriation research in that orientations are characterized by conceptual understandings of those engaged in the PD. Rogers and colleagues identified key characteristics for each orientation and then further defined projects with "PD Project Orientations" (p. 324). Further, this research identified the need for PD developers to pay explicit attention to the PD project orientations when designing sessions (Rogers et al., 2010).

For this current study educational appropriation is understood as a process where a teacher adopts, uses, and modifies pedagogical tools within and influenced by specific social or cultural contexts (Grossman et al., 1999; Leont'ev, 1981; Newman, Griffin, & Cole, 1989; Wertsch, 1991). Many PD providers often assume that teachers implement instructional practices or philosophical ideas taught during a workshop as expected. However, as described by Rogers and colleagues (2007), appropriation of professional learning is only occasionally implemented with full adherence to the workshop objectives. Activity theory is helpful here in identifying the factors that limit teachers'

adherence to expected outcomes of classroom implementation. Rogers and colleagues (2010) described PD in terms of activities, content, and pedagogy; however, PD providers understand these terms in a variety of ways. Use of an appropriation lens enables researchers to more clearly identify what influences teachers to accept new conceptual and practical techniques into their instructional practice by accounting for the multiple factors that mediate their appropriation Researchers have defined these factors as tools and separated them into two categories, *conceptual* tools and *practical* tools (Bakhurst, 2009; Grossman et al., 1999; Jonassen & Rohrer-Murphy, 1999; Leko & Brownell, 2011; Nussbaumer, 2012).

Conceptual and Practical Tools

Developing an understanding of teacher learning requires the knowledge and identification of the pedagogical tools educators use to implement instructional practices. As introduced previously, Grossman and colleagues (1999) distinguish pedagogical tools into two categories, *conceptual* and *practical*. Conceptual tools are the philosophical beliefs, heuristics, or theoretical principles that guide instructional practices across multiple content areas. An example of a conceptual tool would be a guiding principle of scaffolding instruction to reach learning goals. Practical tools have a clearer application and specific use within the classroom (Grossman et al., 1999; Leko & Brownell, 2011). Conceptual tools are overarching ideas that guide teaching and learning that include principles or beliefs about education that influence behaviors providing purpose for engaging students with a particular practical tool.

Practical tools often provide educators with the tasks or material that engage

students. Practical tools might include journaling, behavior management techniques, or specific textbook/workbook materials (Jonassen & Rohrer-Murphy, 1999; Van Duzor, 2011). Practical tools are situated in the immediate context and are exemplified by instructional practices, physical materials, or instructional strategies.

The distinction provided by Grossman and colleagues (1999) provides a useful mechanism to investigate how these two types of pedagogical tools interact with the activity system and each other. The focus on the environmental context differentiates activity theory from other educational research perspectives in that attention is given to contextual influences of pedagogical tools and cultural constraints and how these influences guide individuals to appropriate at varying levels based on adherence or adaptation (Smagorinsky et al., 2004).

Chee and Mehrotra's (2012) discussion of "appropriation model of innovation uptake" or principled adaptation as described by Penuel and Gallagher (2009) provides researchers with a method of understanding how teachers' appropriate PD and their acceptance and implementation of novel instructional practices. This model introduces the concept of shifting PD knowledge to ownership and evolution (Chee & Mehrotra, 2012).

Appropriation is the term that defines the level of an educator's adoption and implementation of ideas and practices provided in PD that are acceptable for use within a given cultural context (Leko & Brownell, 2011; Leont'ev, 1981; Newman et al., 1989; Wertsch, 1991). This process of appropriation is iterative and defines a developmental sequence where both the context and learning act upon each other, creating an

understanding of both that is constantly being transformed. This constant adjustment exemplifies Engeström's (2001) description of mediation. Appropriation of conceptual and practical pedagogy within the PD environment allows learners to internalize and transform their personal concept or understanding of a practice. Appropriation is similar to cognitive theorist's description of accommodation, where the appropriating individual internalizes and adapts ideas or strategies to match their experiences and apply them in a specific context (Ormrod, 2012).

Degrees of appropriation as described by Grossman and colleagues (1999) aid in understanding how various levels of appropriation define how a learner understands and uses pedagogical practices. The five degrees of appropriation are as follows.

1. *Lack of appropriation*—Rejection of a pedagogical practice may occur based on the learner's limited understanding, which makes appropriation impossible. A second reason for a lack of appropriation could be an overt rejection by the learner. This rejection could be based on a cultural divide, philosophical opposition, or other factors. Whether the rejection is exhibited due to limited knowledge or cognitive intent, lack of appropriation demonstrates the antithesis of effective professional development.

2. *Appropriating a label*—This level of appropriation demonstrates the ability of a learner to use terminology yet lack conceptual understanding. Scientific inquiry provides a powerful example of science teachers' use of the term "inquiry" within a classroom yet demonstrate a scripted approach to a science lab. Use of a label could be considered the initial level of appropriation, as it is the first attempt to implement a pedagogical tool through the use of terminology.

3. *Appropriating surface features*—The next level of appropriation is described as using the basic aspects of the pedagogical practice without understanding its connection to purposeful use. An example of appropriating surface features is the use of cooperative learning in a classroom. Initially, the teacher creates groups, with five students in each group; the groups are then provided a general task. Once the group begins to work toward accomplishing the task the teacher engages students in specific responsibilities to support the group in achieving the general objective. This example demonstrates that the teacher understands and is attempting to implement several aspects of cooperative learning yet much of the conceptual foundation of cooperative learning is missing from the implementation. Simply stated the surface features may be present but the theoretical grounding is limited or absent.

4. *Appropriating conceptual underpinnings*—The conceptual level of appropriation is described as an understanding of the purposes for a pedagogical practice and the ability to apply the understanding in multiple settings. It could also be exemplified by an understanding of tacit knowledge where the learner understands the value and basis of using a particular practice yet is unable to describe or use the terminology. A teacher may exhibit the management action of automatically closing a gap between themselves and a disruptive learner, yet be unable to describe what the "use of proximity" accomplishes in the classroom. The capacity to understand both the practice and purpose of implementing a pedagogical tool constitutes the core of appropriating conceptual underpinnings.

5. *Achieving mastery*—Mastery includes the skill to use a practice effectively

and the ability to recognize and articulate the philosophical purpose supporting the tool (Grossman et al., 1999). Mastery includes a level of expertise and wisdom that is produced with multiple interactions with the pedagogy in varied situations. The capacity to enact a practice effectively can be demonstrated by a science teacher using questioning strategies to engage students in evidence-based discourse in a variety of settings and contexts. As discussed previously the multifaceted influences on appropriation are exemplified as mastery level achievement opens further enhancement of the skills for implementing a pedagogical practice (Grossman et al., 1999).

Recognizing and refining our understanding of the role and impact of conceptual and practical tools and their appropriation by educators has the capacity to illuminate the context in which professional learning is provided (Grossman et al., 1999). As teachers engage in PD experiences an understanding of their learning needs can be supported through an understanding of the conceptual or practical frame from which they approach new learning. This individualized approach to professional learning may be key to meeting the diverse learning needs of educators.

Adherence and Adaptation

Along the continuum of appropriation one will find programmed adherence at one end of the spectrum and unbridled adaptation or complete abandonment on the other. Rowan and Miller's (2007) explanation of adherence emphasizes a "programmed" approach to implementation of instruction which aptly describes the current learning experiences of many practicing teachers (Beatty, 2011; Tompkins et al., 2012). Programmed adherence can be understood as a scripted instructional approach

exemplified by ongoing coaching and oversight being implemented in a specified sequence with students (Desimone, Porter, & Garet, 2002; Firestone & Corbet, 1988; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). Some researchers discuss high degrees of adherence in terms of fidelity of implementation to the objectives for the professional learning (Century et al., 2010). Fidelity measures are often intended to articulate a comparison, variation, or an evaluation of the intents in professional learning with what was actually enacted by teachers in the classroom (Century et al., 2010; Penuel & Gallagher, 2009). Yet, the discussions surrounding fidelity often leave little room for localized modification and appear limited when attempting to understand educator expertise in adapting their personal learning to meet the contextual learning needs of students.

In contrast to programmed adherence, adaptive strategies encourage innovative instructional delivery influenced by the immediate social and cultural settings (Rowan & Miller, 2007). An adaptive perspective relies heavily on a teacher's capability to modify curricula adjusting to meet specific learning needs within the local context, which may include unique classroom settings, collegial teacher environments, and administrative oversights (Penuel & Gallagher, 2009). Scholars debate whether classroom teachers have the supports, resources, or skills to make effective adaptations, which creates a dilemma between establishing goals for adherence or adaptation (Ingersoll, 2003; Keys & Bryan, 2001; Meyer & Rowan, 2006; Parke & Coble, 1997; Pea & Collins, 2008; Penuel & Gallagher, 2009; Remillard, 2005). Understanding the connections between adherence and adaptation in relation to how classroom teachers' appropriate professional learning

appears to be a worthwhile investment for educational researchers.

Professional Development Literature

Those charged with developing, implementing, and funding professional learning opportunities have a challenging task. Constructing the objectives and goals of professional learning is clearly a critical phase in the development process, yet this key step should not be done in isolation (Davis, 2003). Shymansky and colleagues (2012) promoted the utilization of "cascading leadership" strategies to develop a positive cultural setting that enable PD projects to leave a leadership legacy, which can stabilize reform efforts. Numerous other researchers have discussed a variety of factors that should be present when designing professional learning experiences (Dane & Schneider, 1998; Grossman et al., 1999; Marra et al., 2011; Penuel & Gallagher, 2009; Rogers et al., 2010; Rowan & Miller, 2007; Van Duzor, 2011). The professional learning elements contained within Table 1 are not exhaustive in nature, but do provide a starting point to developing the heuristics of conceptual tools that PD developers should consider when creating opportunities for teachers.

The similarity of the essential elements of effective PD proposed by multiple researchers is intriguing and comforting. Guskey's (2003) investigation of 13 lists of effective PD characteristics yielded 21 specific attributes of which he focused on five common elements. These five included: (a) a focus on content and pedagogical knowledge, (b) inclusion of appropriate time and other resources, (c) creating a collegial and collaborative exchange environment, (d) evaluation procedures, and (e) a school or

Table 1

Elements of Professional Learning from Previous Research

Element	Description	Scholar(s)
Ownership of instructional practice	PD should include opportunities to make localized modification to instructional innovations. Curricular adaptions or tinkering can be integral to PD internalization	Chee & Mehrotra (2012); Penuel & Gallagher (2009)
Active learning experiences	PD experiences provided to teachers should mirror learner-centered instruction approaches.	Davis (2003)
Ongoing PD	Should include: using past experiences, the importance of research connections, curriculum development as a PD vehicle, and implementation expectations.	Parke & Coble (1997)
Follow-up	In-service programs should contain follow-up experiences with multiple interaction modes to increase efficacy.	Luft (2001); Penuel & Gallagher (2009)
Teachers as learners	Teach teachers in the same manner that they are expected to teach their students. Educative curriculum allows learners to learn with new practices and ideas	Davis & Krajick (2005)
Adaptation vs. Adoption	Adaptation of learning modules enables teacher learners to think about ways of connecting and integrating science across the curriculum.	Shymansky et al. (2012)
Communities of practice	Well-developed learning communities have shown positive impact on both teacher practice and student achievement.	Bausmith & Barry (2011); Shymansky et al. (2012); Visio et al. (2008)

site-based focus (Guskey, 2003). Additionally, Guskey commented on the wide range of effectiveness criteria for PD and that little agreement exists as to the essential elements for PD effectiveness (Guskey, 2003). Additional researchers have provided specific principles of effective PD that align with and extend Guskey's work (Borko, 2004; Desimone, 2009; Desimone et al., 2002; Heller, Daehler, Wong, Shinohara, & Miratrix, 2012; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). A general synthesis of essential elements from the past two decades of research on professional learning is provided in Table 2.

Table 2

Synthesis of Essential Professional Development Elements

Element	Description	*Scholar(s)*
Focus on core ideas—content	Teacher content knowledge growth is key aspect of PD.	Banilower et al. (2007); Bausmith & Barry (2011); Leko & Brownell (2011); Supovitz & Turner (2000); Yoon et al. (2007)
Active learning	Teacher engagement aligns with anticipated student experiences.	Banilower et al. (2007); Davis & Krajcik (2005); Shymansky et al. (2012)
Alignment to teaching goals	PD aligns to teacher interpretation of student learning goals & teaching goals.	Banilower et al. (2007); Penuel et al. (2007)
Designing and adapting curriculum materials	Engaging teachers in the design and adaptation of materials creates active learning and can include educative curriculum.	Banilower et al. (2007); Davis & Krajcik (2005); Parke & Coble (1997); Penuel & Gallagher (2009); Penuel, Gallagher, & Moorthy (2011)
Effective duration	Extended duration, two weeks in length/ ongoing mentoring.	Shymansky et al. (2012); Supovitz & Turner (2000)
Collective participation	Described as effective in sharing and building on teachers' prior understandings and includes building of learning communities.	Bausmith & Barry (2011); Visio et al. (2008)

In an effort to understand these essential elements in professional learning it is important to identify that appropriation is an outcome of these elements and that effective PD can be understood in terms of acceptable adaptation or appropriation. Understanding the specific influential factors that lead to appropriation of new pedagogical practices from PD should include an investigation of these elements (Fogelman, McNeill, & Krajcik, 2011; Forbes, 2013; Hardy, 2013; Rowan & Miller, 2007).

Additional research calls for consideration of professional learning in terms of alignment to district and state assessments, adaptation versus adoption of teaching practice, pedagogical content knowledge, concrete teaching tasks connected to student

interactions, administrative supports, and others (Banilower et al., 2007; Shymansky et al., 2013; Supovitz & Turner, 2000). It is evident that the need for a greater understanding of these elements persists and should be an ongoing line of investigation for researchers in the field.

In an era of Common Core Standards and Next Generation Science Standards (NGSS, 2013) implementation, the question is not whether PD experiences will be provided, but how to develop educator learning experiences that assists teachers in the effective implementation of innovative and effective concepts (principles) and practices (actions). Focusing future PD development efforts on the heuristics discussed previously may provide a process to identify professional learning strategies. Identifying influential factors for pedagogical appropriation through using the activity theory framework holds promise for both researchers and developers of PD (Chee & Mehrotra, 2012; Nussbaumer, 2012; Yamagata-Lynch & Haudenschild, 2006). Ongoing efforts to implement reform-based curricula are a multi-billion-dollar business that should produce positive learning outcomes for students (Bausmith & Barry, 2011; Sawchuk, 2010).

Essential factors that influence appropriation of PD and instructional strategies include opportunities for personalized paths to appropriate conceptual or practical tools, planning for intentional appropriation or principled adaptation as described by Penuel and Gallagher (2009) allowing teachers to develop ownership attributes (Chee & Mehrotra, 2012) of pedagogical tools of instruction to meet contextual learning and instructional needs. The development of an individualized method of PD delivery should not be a foreign practice to our teaching community. Teachers regularly are expected to

differentiate instruction in classrooms (Stradling & Saunders, 1993; Tomlinson et al., 2003). However, consideration of a differentiated instruction model for adult learners in teacher training may be an essential aspect of capitalizing on the investment of time and resources toward implementation of curricula. The challenge for researchers is to understand how PD participants adopt or adapt concepts and practices of instruction in order ways that enable implementation of differentiated professional learning.

CHAPTER III

METHODS

The advantages of using activity theory as a theoretical framework to guide the methodology while investigating educator PD were argued in Chapter II. In the review of literature, a need for educational researchers to continue investigating PD appropriation was demonstrated. This chapter will provide information regarding the methods and processes I employed in researching the appropriation of science PD.

Answering the research questions posed in this investigation required the use of a mixed quantitative and qualitative methodology. Creswell and Clark (2007) indicated that using combinations of case studies and correlated designs are helpful when investigating factors that influence outcomes. This study investigated connections between a science PD experiences with the Cyber-Enabled Learning Project and achievement outcomes of students taught by teachers who participated in this project (Campbell et al., 2014b). Therefore, a mixed design methodology is seen as beneficial for this study.

The use of quantitative methodology is grounded in the purpose of obtaining descriptive or inferential data (Cohen, 2008). Within this investigation descriptive data was employed in the process of participant selection in order to identify teachers who exhibited increased student achievement gains (Creswell & Clark, 2007). Qualitative methodology enables researchers to develop in-depth understandings and rich descriptions of contextual phenomena (Creswell, 2005; Patton, 2002). By using both quantitative and qualitative methods the capture of experiences for teachers who participated in a common PD experience was possible. Gathering teachers'

implementation and meaning making processes through a mixed methodology informed the understanding of PD appropriation (Patton, 2002).

The first section of this chapter describes the rationale for my approach to the investigation as well as its connection with an ongoing NSF project (Campbell et al., 2014b). Subsequent sections inform the reader about the study design including, participants, measures, and procedures.

Rationale

Borko (2004) suggested that research on PD be conducted in three phases. Specifically, Phase 1 should center on individual sites, Phase 2 should target multiple sites and facilitators, and Phase 3 should compare multiple programs and multiple sites. These investigations ultimately inform policies and practices around professional learning. Particularly, this current study seeks to contribute to the PD literature centered on the first Phase of Borko's suggestions. Furthering the understanding of what occurs within the classroom, based on PD experiences, has the capacity to build a strong foundation for practice and teacher learning delivery. Application of the concept of adaptation discussed by Borko holds promising insights as to how teachers incorporate new ideas into practice as a result of engaging in professional learning.

The link between PD and classroom implementation is tenuous at best and absent in many instances (Kazemi & Hubbard, 2008; Knight, 2006). However, current educational reform efforts continue to use PD in historical modes succumbing to the old adage of "if we continue to do what we have always done, we will continue to get what

we have always gotten." In this study, data was collected from classroom observations and used in interviews intended to illuminate factors that influence teacher appropriation from professional learning experiences. This investigative process was used to inform our understanding of the link between classroom implementation and PD.

Design of Study

In this study, I investigated two concepts: (a) extent to which teachers are influenced to appropriate pedagogical tools from PD, and (b) the role that conceptual and practical pedagogical tools play in influencing instruction. I began the investigation with the end result, namely, student achievement data from eighth-grade state science assessments. This method was selected in order to respond to the need for PD to be linked to growth in student achievement. A mixed methodological instrument case study design (Creswell & Clark, 2007) included quantitative data from state end of level testing and qualitative data collected through paired observations and interviews (Christensen et al., 2011; Merriam, 2009). The data were then analyzed to develop an understanding of the phenomenon that occurs as a result of participation in professional learning.

Use of Phenomenology

When investigating a phenomenon of lived experience, such as professional learning events, Creswell (2013) and van Manen (1990) reported that investigators should look to identify common meaning from that lived experience. This common meaning is sometimes described as the essentials of the experience (Creswell, 2013; Dukes, 1984) and provides insight to the phenomena being studied. Phenomenological investigations

align with the theoretical framework of activity theory (Creswell, 2013), in that the observational lens of activity theory attempts to account for multiple influential aspects of a particular experience (Bakhurst, 2009; Bourke et al., 2013; Grossman et al., 1999; Jonassen & Rohrer-Murphy, 1999; Yamagata-Lynch & Haudenschild, 2006). This study focused on the ability of teachers to accept and incorporate new and novel practices from common PD phenomenon. As in many experience centered learning settings, appropriation appears to be influenced by multiple factors (Chee & Mehrotra, 2012), such as administrative directive, peer collaboration, or previous personal experiences. The multiplicity of influences on the phenomena of teacher learning demonstrates the value of using activity theory as the framework for this phenomenological investigation (Bourke et al., 2013; Jonassen & Rohrer-Murphy, 1999; Yamagata-Lynch & Haudenschild, 2006).

Participants

For this study, quantitative and qualitative data were collected from eighth-grade integrated science teachers who participated in a NSF DRK-12 grant targeting Cyber-Enabled Learning within the science classroom (Campbell et al., 2014b). The Principle Investigator of this project saw value in collecting data that could inform how appropriation levels could be influenced for science education PD. A letter supporting this particular investigation is provided in Appendix C.

During the course of data collection within this ongoing project, differences in student achievement were observed when comparing the intervention group (science teachers participating in PD) with the control group (comparable science teachers not

participating in PD; Campbell et al., 2014b). It was anticipated that identifying and defining what occurs once the participating teacher's classroom door closes could inform explanations of the perceived student achievement difference.

Professional Development

The goal of the Cyber-Enabled Learning PD project was to enhance teacher and student learning by providing learning modules and instructional strategies focused on using technologies, such as information communication technologies (ICTs), in ways that contributed to new literacies development and the development of science literacy using an inquiry mode of science instruction (Campbell, Longhurst, Wang, Hsu, & Coster, 2015). To accomplish this goal, the Cyber-Enabled Learning project used educative curriculum (Davis & Krajcik, 2005) to ground the PD experience for participants.

For the project, educative curriculum was understood as curriculum that promotes experiences placing the teacher in the role of a learner. During each year of PD, two curriculum modules (7 to 9 days) were created by the project leadership team and used as learning anchors for teacher participants and their students. The modules were developed using a modified version of Slater, Slater, and Shaner's (2008) backward faded scaffolding inquiry. In this model learners increase in independence over three iterations of connected investigations (Campbell et al., 2015).

The PD model use a theory of action where teacher participants engage as learners in the project and assisted in the development of curriculum and enacted that curriculum upon return to their classrooms. This process intentionally influenced their content and pedagogical knowledge that enhanced their learning, teaching practice, and

student learning. The 2-year PD experience consisted of summer workshops (2 weeks), school-year monthly meetings (one after school meeting per month), and winter workshops (3 days).

These teachers had experienced a common PD delivery, which was used to inform an understanding of appropriation of learning from PD. Through the use of the quantitative data teachers of students who exhibited higher achievement were identified as potential research participants. According to Creswell (2013), purposeful sampling should be used in order to identify individuals with common experiences with a phenomena and common outcomes (Polkinghorne, 1989). For this study, a purposeful sampling strategy required the intentional selection of participants who demonstrated high achievement providing rich sources for investigation (Creswell, 2005; Patton, 2002).

As shown in Table 3, two groups of teachers were included in the participant selection pool for this study, namely Cohort 1 and Cohort 2. It was determined to use teachers from Cohort 2 for this study based on a purposeful selection (Creswell & Clark, 2007). This cohort had completed the full 2-year PD sequence prior to the 2014-15 school year. Cohort 2 consisted of nine practicing teachers, five female and four male,

Table 3

Cohort Teacher Explanation

Cohort	Teacher	Male	Female	Description
Cohort 0	19	NA	NA	Nonparticipating teachers (Control)
Cohort 1	13	5	8	Project Year 1 participating cohort (selection pool)
Cohort 2	9	5	4	Project Year 2 participating cohort (selection pool)
Cohort 3	8	5	3	Project Year 3 participating cohort (delayed treatment group)

with a wide range in age and teaching experience. Cohort 2 also included teachers from three districts located within suburban communities in the Western U.S.

Data from the nonparticipating group as well as a delayed treatment group, Cohort 3, were included as controls. Both the nonparticipating group and Cohort 3 were similar in teaching experience, school locations, and additional demographics when compared with the cohort teachers who had participated in the PD. Cohort 0, the nonparticipating group, included 19 eighth-grade science teachers. The delayed treatment group, cohort 3, had nine teachers, but only eight teachers had student data connected to previous students due to one teacher being in his first year. In order to inform the purposeful selection of participants an ANOVA was conducted to evaluate the achievement among students of teachers from the various cohorts.

Ultimately, two teachers were selected. These teachers were both mid-career science teachers (10-15 years of teaching) and both were female. The two individuals taught in different districts, but experienced the PD within the same timeframe and both were in Cohort 2. Selecting an appropriate number of participants in qualitative research presents a challenge. However, researchers indicated that a small number of telling cases can be informative (Creswell, 2013; Dukes, 1984; Wertz, 2005; Zabloski & Milacci, 2012). Therefore, I selected a small number of participants (two) enabling me to spend the necessary amount of time in observing and identifying factors that influenced these particular teacher cases' in the appropriation of instructional practices.

Additional detail regarding the quantitative data and the participant selection is included in Chapter IV as part of the results and data analyses.

Measures

Participating teachers were selected based on the quantitative measures discussed previously and invited to participate during the 2014-15 school year. An informational letter (see Appendix A) was provided and a signed informed consent (see Appendix B) was obtained in accordance with the Utah State University (USU) Internal Review Board (IRB; Protocol # 5979) approval for each participant. A mixed method of quantitative measures and qualitative observations/interviews provided informed data for this study.

Quantitative Student Achievement

Grade level state administered science achievement data obtained through the district representatives was used to determine whether differences existed between students of teachers who had participated in the PD and those who had not. These state tests are predominantly multiple choice with some questions grouped together by data tables or scenarios. This assessment is based on the state core curriculum and aligns to the science content targeted in the Cyber-Enabled Learning Project (Campbell et al., 2014a). The [quan → QUAL] design (Christensen et al., 2011) connected both quantitative data demonstrating student achievement gains and classroom descriptions of factors influencing teacher appropriation of professional learning.

Classroom Observations and Interviews

Qualitative data were collected in a series of five classroom observations, interviews, and also included written member checking opportunities. Observations and interviews occurred during the 2014-15 school year concluding in January 2015.

Following the initial interview, five subsequent paired observation/interview sessions were conducted to establish a broad understanding of the pedagogical practices being used by each of the participants (see Table 4). Student interviews were not deemed essential to this investigation and are therefore noticeably absent from the procedure. Interestingly, multiple students sought opportunities to engage in conversation with me during the observations. Each observation focused on identifying activity anchors for use in the paired interview (see Appendix D). The use of video within the classroom was also considered, but for this investigation it was determined that the use of video could create a formality within the interview that would decrease the open dialogue being sought.

Participant interview questions were initially developed and then followed a

Table 4

Investigation Procedure

Investigation phase	Description	Timeframe
Selection process	Purposeful sampling utilizing quantitative data	September 2014
Invitation to participate	Selection based on analysis of achievement data	September 2014
Preobservation interview	Project description, scope of participation, and trust building	October 2014
Observation/interview 1—5	Class period observation paired with interview informed by observation and previous interactions	Fall 2014
Member checking 1—5	Member checking of transcript and interview documents	Following observation
Member checking	Participant review and response of individual description	Ongoing
Data analyses	Constant comparative analysis will occur throughout the data collection period.	Winter 2014

semistructured format informed by both observations and previous interview dialogue (Merriam, 2009). Interview question exemplars are provided in Appendix E as part of the Appropriation Participant Interview Record.

Open, Axial, and Selective Coding

During the observations classroom instruction episodes were identified for use as anchors of key discussion items linked to semistructured interviews (see Appendix E). Analyses of classroom observations, participant interviews, interview transcriptions, and study field notes were conducted to identify emergent themes of the data. By following the [quan → QUAL] design, I was able to conduct iterative observation/interview experiences enabling access to rich phenomenological descriptions of teacher appropriation (Christensen et al., 2011).

Procedures

As indicated previously, this mixed methods case study was initiated with a quantitative analysis of student achievement data from participating teachers in a currently operating NSF DRK-12 grant (Campbell et al., 2014b). Quantitative data were used to inform a purposeful selection process of science teachers from the Cyber-Enabled Learning Project for invitation to participate. The quantitative analyses included both a descriptive and cluster analysis to inform the purposeful selection of participating teachers (Creswell & Clark, 2007). In addition to the quantitative analyses informing the participant selection qualitative data from the providers of the PD added additional information for this selection process.

Participant Selection

Quantitative data were analyzed using a descriptive and cluster analyses to select teacher participants who demonstrated student achievement gains statistically different than control populations (Creswell & Clark, 2007). Additional qualitative input was used in an effort to validate the trustworthiness of the quantitative data. Final selection of participants was informed by both statistical data and input from the project experiences

Interview Data

I used a semistructured interview format (see Appendix E) enabling the identification of emerging data during the observation and subsequent paired interview. Each interview included introductory questions followed by anchor activity questions (see Appendix E). Anchor activity questions were developed during the classroom observation and articulated using descriptive terms versus educational jargon that might easily be misinterpreted by either the participating teacher or myself. An example of an anchor activity is the use of questions during the course of a classroom dialogue to challenge a particular student to provide evidence for a claim they had made. Open-ended questions were used during the initial interview and revisited as necessary during subsequent discussions (e.g., Discuss your teaching practice? or Help me understand…; see Appendix E). During each interview, depth questions were developed based on themes that emerged from prior interview topics, classroom observations, and other participant interactions. I was able to inquire about ideas and concepts that were not visible at the outset.

This data collection process enabled me to access multiple examples from the

lived experience of these two teachers that informed my research questions. Each interview provided an opportunity to discuss the extent that teachers are influenced to appropriate pedagogical tools from professional development (Research Question 1). The role that conceptual and practical tools play in the appropriation of instructional strategies associated from PD also became a ongoing guide in our conversations (Research Question 2).

The interviews were not intended to place a burden on the participating teachers and were therefore held to a total of 30 minutes, 20 minutes for questioning, and 10 minutes were allocated for reviewing and responding to prior interview transcriptions and completing personal appropriation trajectories. In one instance, the approving district requested that the interview timeframe be reduced in order to limit the burden on the teacher. I complied with this request by reducing the number of questions and time spent during the interview with this teacher. The number of observations and interviews matched for both participants with one teacher having a reduced amount of interview time. Interestingly, this teacher provided three additional self-created and unsolicited documents providing additional detail to our conversations. Member-checking activities included: reading of transcripts, follow-up email communication, and personal appropriation trajectories (see Appendix F) that were intended to provide triangulation data increasing the validity of the information. Personal appropriation trajectories were limited to participant report and perceived disposition in relation to appropriation levels, which furthered the understanding of individual progression within appropriation levels.

Following each observation/interview, transcription of the audio-recorded

discussion was completed. As the transcripts became available a sequence of data analysis described by Christensen and colleagues (2011) was initiated and included: open coding, axial coding, and selective coding allowing emergent data to be recognized (Spradley, 1980). Table 5 provides a description of the coding sequence and the methods used. A constant comparative method was employed in order to use data to constantly inform the investigative process (Glaser & Strauss, 1967). In a constant comparative method interview transcripts and data are analyzed throughout the data collection process informing subsequent observation/interviews. When analyzing the data, each transcript was reviewed in a holistic manner to obtain general impressions from each teacher. During the initial review the transcription document was compared to the audio recording to verify that the text accurately represented the interview dialogue. Additionally, theme

Table 5

Coding Sequence and Coding Methods Detail

Coding Phase	Method	Description
Open coding	Initial review	Transcripts were reviewed line-by-line with audio recording for errors and interview note consistency.
	Descriptive coding	Emergent themes were identified and compared during the review and subsequently color-coded by theme.
Axial coding	Secondary review	Transcripts were read again for evidence of factors connected to emergent themes and broad concepts were reduced to factors linked to themes.
	Pattern coding	Broad concepts were reduced to identifiable factors that lead to themes. These were then color-coded and grouped.
Selective coding	Tertiary review	Transcripts, factors, and themes were reviewed for commonalities and similarities across emergent codes.
	Focused coding	Factor → Theme → Outcome connections were then developed.

based topics were recorded and synthesized. The emergence of themes and the horisonalization of this data provided avenues for subsequent data reviews (Creswell, 2005; Merriam, 2009; Moustakas, 1994).

During the transcript analysis, noteworthy statements from each transcript were identified in order to develop a group of themes that informed an understanding of the phenomena (Creswell, 2013; Moustakas, 1994). I read each transcript and identified significant statements by highlighting the phrase within the transcript. I then grouped the themes according to broad categories in order to identify unique and nonrepeating comments from the participants. The emergent themes, developed during open coding were then revisited to determine if common subcomponents existed that could provide further explanation to the phenomena (Creswell, 2005; Merriam, 2009).

Each semistructured interview was informed by insights gained during the paired classroom observation. Guiding questions were developed around the observation anchors for use during the interview. Interpretive validity was minimized by inviting participants to member check the interview transcripts and provide written explanation of perceived miscommunications (Christensen et al., 2011). The length of each member checking experience was held at a minimum as not to place undue burden or pressure on the participating teacher; however, one participant engaged deeply in this opportunity which resulted in limited interview time.

The investment of time and energy in conducting the analyses described allowed me to be immersed in the data. Reviewing each transcription multiple times helped me develop a more complete understanding of the participants' experiences that were

informed by the personal interview and the textual connection. As a researcher I engaged in an interpretive process of identifying the essence of participants' experiences, which developed a richer and deeper description of the factors that influence instructional change (Creswell, 2013; Moustakas, 1994).

As emergent data became evident the structure and focus of the observations and interview were adjusted to further illuminate these data. In this way the participating teachers became more cognitively aware of their appropriation efforts, thus providing a unique participant/researcher perspective to the data (Davis, 2003). Further discussion of the emergent themes will be provided during the analysis in Chapter IV.

Validity

In order to reduce the impact of interpretive validity concerns member checking was employed at various stages using both verbal and written response methods (Christensen et al., 2011). Using a second observer was considered to reduce the descriptive validity concerns; however, the benefit I, as the sole researcher, provided was seen to be more beneficial to data collection based on the collegial connection previously developed during the Cyber-Enabled Learning Project. The case study design of this research may have limited utility in a cross-case analysis, as it contains aspects of grounded theory thereby limiting the possible cross-case comparisons (Christensen et al., 2011; Glaser & Strauss, 1967). Although there are five classroom observations, for each participant, it is apparent that all the nuances of teaching and learning may not be manifest during the observation/interview sessions. Further, the limitations of this study

stem from the small number of participants and it is anticipated that future researchers might replicate and extend this work.

The concern of internal and external validity must be addressed in every study. In the case of this mixed method case study, internal validity focused on making sure that the research findings accurately reflect and align to the phenomenon. Essentially, was I able to capture the phenomenon? In this study I employed two techniques to improve validity. First, I used constant comparison of data allowing for triangulation (Glaser & Strauss, 1967). Second, member checking (Christensen et al., 2011) occurred throughout the data collection process in order to have the participants clarify any possible or perceived misunderstandings or misinterpretations.

In a qualitative study, external validity focuses on how data collected in these specific case studies can apply to the general population. This is a challenge in that the data from the selected participants must be understood deeply enough to demonstrate transferability (Van Duzor, 2011). In this investigation, I used rich, thick description to provide readers enough understanding to determine if the data collected matches the research context. Information collected from observations, interviews, and member checking reviews are all included in a "highly, descriptive, detailed presentation of the setting and in particular, the findings of the study" (Merriam, 2009, p. 227).

CHAPTER IV

RESULTS AND DATA ANALYSIS

Qualitative and quantitative data collected informing this study will be shared within this chapter. The nature of mixed methodology enables researchers to overcome some of the weaknesses of using a single approach (Creswell & Clark, 2007). Therefore, I begin this chapter with a description of the quantitative process for selecting this study's participants from individuals in the Cyber-Enabled Learning Project (Campbell et al., 2014b). This selection process used quantitative student achievement data from state assessments followed by a qualitative purposeful selection (Creswell & Clark, 2007). Subsequent sections of this chapter will then describe the qualitative data collection process employed for the remainder of the study. Multiple instruments were used for the qualitative investigations including, observations, interviews, written correspondence, and participant member checking. Each set of data will be introduced in the context of the study allowing readers access to data connections that were identified. Following the presentation of data I will describe how the data informs this study. Chapter V will then be devoted to the discussion of these data.

Participant Selection

The selection process for this study was initiated with a quantitative analysis of student achievement data of eighth-grade students' end-of-level assessments in a Western U.S. state. Students within this state are examined through the use of an end-of-school-year science assessment known as the criterion reference tests (CRT). This assessment is

administered to all eighth-grade students within the state and is, therefore, a common instrument that was useful in the comparison of cohorts and individual teachers within cohort groups. Initial project data comparisons indicated differences among students who were taught by teachers from participating PD cohorts and nonparticipating groups, which precipitated the desire to investigate differences among individual teachers.

In order to make appropriate comparisons of nonparticipating teachers and participating teachers it was determined to compare multiple groups. Students who were taught by nonparticipating teachers had no contact with the PD treatment and were deemed a control group that was similar to the treatment groups in terms of student population and other factors that may have influenced the teachers since they are from the same districts.

Cohorts 1 and 2 were in various stages of the treatment and were identified as target groups for participant selection in this study on appropriation. The Cohort 3 provided data from students who were taught by a group of teachers who had also been selected for participation in the professional learning, but at the time were not involved in the project. This group provided data from a set of teachers who were both similar in student population and the desire to participate in the PD.

Determination of the teachers to target for participation in this appropriation study was made by selecting teachers who would have culminated their participation in the Cyber-Enabled Learning Project at the time of data collection. Based on these criteria, it was determined to analyze the achievement of students taught by Cohort 2 teachers (see Table 6). Individuals from Cohort 2 were compared to Cohort 0, Cohort 1, and Cohort 3.

Table 6

Descriptive Explanation of Cohorts

Cohort	Teacher *N*	Student *N*	Description
Cohort 0	19	2708	Nonparticipating teachers from the same districts
Cohort 1	13	1073	Participating teachers (after 2 years of participation)
Cohort 2	9	1134	Participating teachers (after 1 year of participation)
Cohort 3	8	1019	Delayed treatment group (prior to participation)

Students taught by Cyber-Enabled Learning Project participants were measured using the results of a state-administered CRT according to the state standards. Table 6 contains a set of descriptive statistics for each of the cohorts within the project.

A one-way analysis of variance (ANOVA) was conducted to evaluate if students of teachers from different cohorts, including control cohorts, differed in their achievement on CRTs. The ANOVA was statistically significant, $F(11, 5976) = 16.14$, $p \leq .0001$. A main effect of student achievement was present on PD participation. The 12 groups in the ANOVA means comparison are comprised of three groups (Cohort 0, Cohort 1, and Cohort 3) and individual teachers from Cohort 2.

Follow-up analyses using Fisher's least significant difference (LSD) were conducted to evaluate planned pairwise differences among the group means (see Table 7). Student achievement of teachers who had participated in the PD for 2 years (Cohort 1) was statistically different when compared to the means of nonparticipating teachers, Cohort 0 ($p \leq .0001$) and delayed treatment teachers, Cohort 3 ($p < .0001$) groups. Although lack of statistical difference is not necessarily informative, this data indicates no difference between nonparticipating and delayed treatment groups. No difference

Table 7

Results of the One-Way ANOVA

Source	*SS*	*df*	*MS*	*F*
Between treatments	55938.31	11	5085.30	16.14
Within treatments	1883412.41	5976	315.16	
Total	1939350.72	5987		

between student outcomes of nonparticipating teachers, Cohort 0, and delayed treatment teachers, Cohort 3, was seen. On average, students who were taught by teachers participating in the Cyber-Enabled Learning PD had higher achievement scores than those not participating.

Because PD participation (vs. nonparticipation) significantly impacted student achievement, planned follow-up tests were performed. I employed LSD multiple comparisons tests to determine individual differences within Cohort 2 and other cohorts. These comparisons are provided in Table 8.

Students of three teachers participating in the PD demonstrated significant achievement differences, namely Teachers 1, 2, and 4 (see Table 7). Students who were taught by these three teachers outperformed the comparison group (Cohort 0). In additional analyses, these three teachers were also compared with Cohort 3, producing similar results not shown in Table 8. These three teachers were identified as viable participants for further investigation. In subsequent qualitative and practical reviews of these individuals it was determined that Teacher 4 would not be included due to a change in employment outside of the collaborating district and the information that he was no longer teaching eighth-grade science.

Table 8

Follow-Up Tests Performed: LSD

Cohort	Teacher /cohort	Mean difference	*p*
Cohort 0	**Cohort 1**	**-4.53**	.000*
	Teacher 0, Cohort 2	4.68	.007
	Teacher 1, Cohort 2	**-5.57**	.000*
	Teacher 2, Cohort 2	**-8.55**	.000*
	Teacher 3, Cohort 2	-3.18	.036
	Teacher 4, Cohort 2	**-10.30**	.000*
	Teacher 5, Cohort 2	3.68	.006
	Teacher 6, Cohort 2	1.66	.396
	Teacher 7, Cohort 2	-.74	.692
	Teacher 8, Cohort 2	8.01	.001
	Cohort 3	-.23	.728

Note. Groups or individual teachers with higher means than the control/comparison groups are in boldface.

* $p \leq .0001$.

Data from this quantitative data analysis were used to identify Renee (pseudonym for Teacher 1) and Bonnie (pseudonym for Teacher 2) as participants for this research study targeting appropriation of pedagogical practices from PD. Following USU IRB-approved protocols, written district approval was obtained prior to initiating contact with the individual teachers. Initial contact was made through email and then Signed Informed Consent (see Appendix B) was obtained from Renee and Bonnie. Five paired observation and interview sessions were then arranged to accommodate each teachers' schedule.

Bonnie

Bonnie was an eighth-grade integrated science teacher in a suburban school

district in the Western U.S. She had recently moved schools and was adjusting to both a new setting and new support systems at the time of the observations. She was a mother of young children and often viewed teaching from a philosophical belief that as an educator she should "challenge kids to stretch themselves and think more." Bonnie had taught for eight years in science classrooms.

Renee

Renee received her education degree and taught for 2 years prior to stepping away from teaching to be a stay-at-home mom and raise her family for 12 years. She had returned to the classroom 4 years prior to this study and was currently teaching eighth- and ninth-grade science courses in a suburban middle school. She also taught in the Western U.S. approximately 15 minutes from Bonnie. Renee participated in the Cyber-Enabled Learning Project (Campbell et al., 2014a) with two other members of her science department, giving her a unique support system within her school.

Summary of Quantitative Analysis

The determination of participants for this study was made through a quantitative analysis informed by qualitative knowledge of the individuals within the Cyber-Enabled Learning Project (Campbell et al., 2014a). In summary, students of teachers who participated in the PD demonstrated significant increases in their science achievement as measured by state administered CRTs. Two specific teachers, Bonnie and Renee, were selected due to individual comparisons that demonstrated high student achievement. The selection process provided quantitative data supporting a more in-depth look into the

classroom and experience of these two teachers.

Preliminary Analysis: Open Coding

Upon obtaining approval for the study and arranging observation and interview sessions, interview data were collected and transcribed for review. Following Merriam's (2009) guidance, I employed an open coding analysis followed by subsequent axial coding and selective coding analyses. During the analysis phase of this study, I connected both cases by providing evidence of similarities exhibited by both teachers during their individual observation and interview sessions. The purpose for connecting the data was to limit any dichotomous comparisons that may have developed between these two individuals. The analyses focused instead on the similarities of the cases informing how appropriation occurred in connection with increased student achievement.

During the initial analysis of the transcription data, I was able to read each transcript while listening to the audio recording. This process enabled me to review and correct errors in the data as well as take note of the conversation tone that would not have been possible through limiting myself to a text based analysis (see Table 5). While conducting this initial analysis using open coding, three themes emerged from the conversations with these two teachers.

The first two themes included a focus on conceptual understandings and practical applications that were developed as a result of the PD participation (Grossman et al., 1999; Penuel & Gallagher, 2009; Shymansky et al., 2012). These two themes align with prior research being conducted and support the attributes of activity theory, namely

conceptual and practical tools (Bakhurst, 2009; Longhurst et al., 2015). Bonnie and Renee consistently discussed the concept of ownership in addition to the themes of conceptual and practical tools. Interestingly, both conceptual and practical inputs were used when describing the idea of ownership (see Table 9).

As evidenced in Table 8, Bonnie consistently used terms such as "challenging kids" and "think for themselves" to describe what she conceptually wanted to provide through her teaching practice. This evidence suggests that she has a philosophical concept that includes providing more than basic activities for learners. Renee's example of using Splice, a technological software tool, provides an understanding of the need for teachers to connect to what they will actually do in the classroom. Finally, the connected nature of conceptual and practical tools is demonstrated when Renee was challenged to identify where she gained her understanding. Her response was, "Well, maybe a mix of

Table 9

Evidence of Emergent Themes During Open Coding

Theme	Interview	Participant	Evidence
Conceptual input	2	Bonnie	"…it's given me the *clarity* of what it is I actually wanted besides challenging kids… I wanted them to be independent and *to think for themselves*"
Practical input	3	Renee	"I *used Splice* (software application) a lot in eighth grade because that was the only thing I really knew."
Ownership with conceptual	5	Bonnie	"…the philosophy and *what I'm really doing and why I'm doing it* makes a difference. What I wanting to accomplish as a teacher. *What do I want the kids to accomplish*?"
Ownership with practical	4	Renee	*Interviewer:* Is that your idea of a scaffolded approach—would you have come up with that on your own, or is it something from the PD? *Interviewee:* Well, maybe *a mix of both*.

both." This response provides some indication that she connected to her personal ownership of a teaching approach with PD, but was not able to cognitively identify the origins of her pedagogical knowledge. These three themes will now be discussed in depth in order to establish an understanding of how they connect to one another.

Emergent Theme: Conceptual Tools

The interview data initially developed in two basic areas, conceptual and practical categorizations of pedagogical understandings. The first of these two categories is the conceptual or philosophical mindset that Bonnie and Renee felt they needed to possess (see Table 10). Both participants described a conceptual "shift" that they experienced as a result of participation in the Cyber-Enabled Learning Project (Campbell et al., 2014a). Bonnie stated that she "…focused on a philosophical shift versus the worksheet that I will pass out on Thursday or the activity I will do next week or the science experiment that I will do in a month from now." Researchers (Hardy, 2013; Rogers et al., 2010) described conceptual tools in terms of the philosophical ideas or reasons for particular practices and make a link between philosophical and conceptual understandings. Table 10 provides additional evidence for the conceptual theme.

The conceptual purpose for understanding new pedagogical practices appears to be a key component in how a teacher evaluates the utility of a PD experience. In Table 10, Bonnie uses the phrase "the biggest thing" to explain her conceptual purpose for the instruction she delivers to students. Knowing the purpose for a particular teaching module seemed to be valued more than the specific steps of teaching a module. Generally, Bonnie and Renee provided numerous examples of how concepts were

Table 10

Evidence of Emergent Theme: Conceptual Tools

Theme	Interview	Participant	Evidence
Conceptual	1	Bonnie	"I haven't in my actual classroom necessarily done the same experiment but *it's applying the concept* of introducing it with a more modeled teacher approach, and then growing to the independence through *teaching in concept*."
Conceptual	1	Renee	"*My point of the assignments* is that they're gathering and learning information."
Conceptual	2	Renee	"For me, my understand—*I get the concept*, but writing it, I have a hard time with that. It helps me to share with each other and try it out, and then the concept becomes more concrete in my mind."
Conceptual	2	Bonnie	"The *biggest thing* for me is what can I do as a teacher to help the kids be successful when they go out on their own?"

translated into additional areas of their teaching. One specific example provided by Bonnie, when describing the concept of iterative learning, a topic targeted by the PD providers was:

> The main thing that I've taken away from project is the iteration concept of taking it step-by-step. I haven't in my actual classroom necessarily done the same experiment through the three different steps, but it's applying the concept of introducing it with a more modeled teacher approach, and then growing to the independence through teaching in concept.

This example demonstrated Bonnie's need to conceptually understand a pedagogical practice in order to effectively implement it into her teaching repertoire.

Conceptual understanding appears to have a deep impact on how a teacher uses pedagogical practices from teacher training experiences. In these cases the teachers identified with conceptual understandings as they exhibited efforts to implement practical applications. However the data also demonstrates that the opposite also occurs. Namely,

teachers identify with practical tools prior to crystalizing a value or conceptual purpose for implementing a practice.

Emergent Theme: Practical Tools

The next emergent theme was that of using practical tools in efforts to enhance instruction. Practical tools can be understood as the physical materials or specific teaching practices that a teacher might employ in the delivery of instruction (Grossman et al., 1999; van Driel et al., 2001). While conceptual tools are considered *why* the practice or instruction is worthwhile, practical tools focus on *what* occurs. Renee provided evidence of this distinction when she said, "They write a definition, and they've got the work done, but it still doesn't make any sense to them." For Renee there is a clear distinction between learners being able to complete a task and learners understanding the phenomenon.

Practical tool development within a teacher learning setting does not appear to be vastly different than that of students' classroom. In my fifth interview with Renee, she linked her learning experience with what she was providing to her students. She said, "…most of the people that were part of the [Cyber-Enabled Learning] presentation were posing things to think about. Which now I, as I say it, I realize, that's probably modeling what we're doing with our students." Renee realized the value of modeling practical tools during her learning and connected it to how she would use these practical models as she instructed her students. Table 11 provides further evidence for practical tool use from my conversations with Bonnie and Renee.

The balance between conceptual and practical dispositions appears to be

Table 11

Evidence of Emergent Theme: Practical Tools

Theme	Interview	Participant	Evidence
Practical	3	Renee	"Then something that Bonnie did that I really liked was she put some *Google forms* on her website that allowed kids to submit documents to her so that she wasn't just getting email after email after email of the documents. *I also created a form* on my website which the kids could then copy their link into the form."
Practical	2	Bonnie	"…we were consistently meeting and getting feedback and thoughts from other people in different schools, trying it in different ways, made it easy to be consistently trying to actually utilize it and have the time to do it *instead of it still being left in concept* and wanting to but not getting to it."

necessary to influence movement along the appropriation hierarchy. As described previously, the lens of activity theory allows me to identify the multiple influential factors within a setting or context. As the themes of conceptual tools and practical tools emerged both appeared to be connected to the idea of ownership. As this occurred I was able to see how teachers might balance between conceptual and practical dispositions in an effort to "own" a pedagogical practice. The next section will provide evidence of the attributes of owning a pedagogical concept or practice.

Emergent Theme: Ownership

In their discussion of appropriation, Chee and Mehrotra (2012) introduced a model of uptake providing an explanation of how teachers accept and implement new instructional practices. In this model they introduce the concept of shifting ownership of a pedagogical practice from the PD provider to the individual teacher learner. During the

course of analyzing the interview data from this study, multiple instances of blending conceptual understandings with practical knowledge were identified. Bonnie and Renee both used ownership terms when referring to their teaching practice. For example, in Renee's response to a question about use of technology tools during the first interview she described a classroom discussion about finding credible resources. Her comments regarding her personal willingness to allow students to conduct an Internet search demonstrated a quality of owning a practice. Following her description she commented on the example by saying, "I just think that is something I normally wouldn't have done." She was able to describe her new possession of a conceptual teaching practice in terms of what pedagogies she is personally willing to use.

It appears that teachers experiencing PD can develop ownership of new pedagogical practices through both conceptual and practical inputs. Ownership of a pedagogy seems to be influenced through interactions with conceptual understanding and practical applications as represented in Figure 4. Additional evidence of a blended

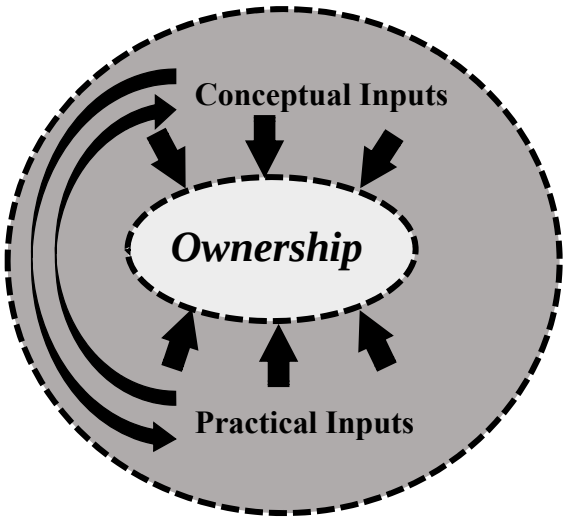

Figure 4. Conceptual/practical input to ownership development.

development process, owning a pedagogical practice, is provided in Table 12. Additional data from Renee and Bonnie provided further indication that conceptual and practical internalization (ownership) is influenced by a host of factors. Therefore, activity theory continues to be a valuable theoretical framework as a means of elucidating these multiple factors and their influence how teachers appropriate pedagogical principles and practices (Bakhurst, 2009; Bourke et al., 2013; Grossman et al., 1999; Jonassen & Rohrer-Murphy, 1999; Yamagata-Lynch, & Haudenschild, 2006).

During the Cyber-Enabled Learning PD, Renee and Bonnie appeared to absorb ideas, opinions, beliefs, and other teaching attributes in ways where those attributes were assimilated into their individual teaching character. Both individuals demonstrated characteristics of conceptual and practical tool use. However, internalization or ownership did not always develop for each practice. Specifically, Bonnie and Renee were both influenced toward ownership by various factors including their peers, administration, and exposures to the new pedagogical practice. Illumination of these

Table 12

Evidence of Emergent Theme: Ownership

Theme	Interview	Participant	Evidence
Ownership (tailor design)	2	Bonnie	"The biggest thing for me is what can *I do* as a teacher to help the kids be successful when they go out on their own? That really tailors how *I design* what type of activities *I provide* to the students."
Ownership (student talk)	3	Renee	"Rather than talking about the tool that *I use* to teach or for them to share information with me, talk about what *I'm trying* to get them to share?"
Ownership (value)	Member check 1	Bonnie	"They need to *value* learning over task completion, so *as a teacher*, *I need* to provide learning opportunities not task completion activities."

additional factors of influence was the purpose for a subsequent axial analysis of the observation and interview data.

Summary of Open Coding

During the open coding analysis general concepts, impressions, and thoughts were identified from observations and paired interviews. As this data was reviewed, themes emerged in three areas (see Table 13). This preliminary phase of the qualitative analysis offered an opportunity, through open coding, to synthesize general concepts that were evident throughout the data collection process (Merriam, 2009).

Secondary Analysis: Axial Coding

Following the initial open coding of the interview data a secondary axial coding was conducted to support the understanding being developed from the emergent themes.

Table 13

Open Coding Theme Development Interpretations

Theme	Researcher interpretations
Conceptual inputs	This theme emerged as Bonnie and Renee described *why* they teach. Purposes for instructional practice seem to be necessary for teachers to invest in efforts to appropriate new ideas or concepts of instruction.
Practical inputs	In many instances within this study Bonnie and Renee provided particular examples of *what* they were doing in their classrooms. It appears that in education teachers, PD providers, and administrators can be singularly focused on the acts within the classroom with limited connections to the purposes. The data collected from this study creates a distinction between the conceptual and practical.
Ownership	As examples of conceptual inputs and practical inputs were identified, attributes of each began to connect with the idea of internalization or ownership of the idea or practice. These attributes of ownership continued to surface through the entire sequence of open coding.

Coding is described as one of many ways to appropriately analyze qualitative data (Saldaña, 2011). Axial coding is often described as analytical coding that goes beyond descriptive coding and is derived from the interpretation of meaning (Corbin & Strauss, 2007; Merriam, 2009; Richards, 2005). In this portion of the investigation, I examined the transcripts to determine if patterns or connections existed between the themes and other elements influencing Bonnie and Renee's appropriation of new pedagogical practices. During the axial coding, influential factors that mediate the emergent themes became evident. The factors included:

- Time
- Goal alignment
- Support and dollaboration
- Synthesis and understanding
- Engagement
- Adaptation and modification
- Relevancy and value
- Practice

These influential factors are viewed as ways that teachers develop and use conceptual or practical tools in their personal understanding of instructional pedagogy. Each factor will now be discussed in detail with exemplars provided from participant interviews. Within this analysis I used Erickson's (1986) balanced model of differentiating for qualitative description that includes a particular description, consisting of quotes from interviews, followed by a general description, describing how the data is typical as a whole, and

finally an interpretive commentary providing a frame for understanding both the particular and the general descriptions (Erickson, 1986).

Influential Factor: Time

During the my conversations with Bonnie and Renee I found that both individuals provided evidence that time was a factor affecting their ability to incorporate concepts or specific practices into teaching. This factor of time appears to be key in both the development of conceptual tools and practical tools. Interestingly the time needed for conceptual tool development appeared to be centered on reflection. Alternatively the time for practical tool appropriation included a need to practice or tryout the specific tool.

Particular description. In an effort to provide particular evidence of the factor being discussed I have elected to identify multiple examples from the interviews conducted for this study. Providing multiple excerpts from the interviews will demonstrate particular support for identification of a specific factor. In discussing time, Bonnie provided examples of how time was critical in her appropriation of new conceptual and practical tools. In discussing her use of specific lesson plans, Bonnie stated:

> One of the things that I loved about it was we had the time to do things but the time to reflect on how does that actually fit with me and what I'm doing? We did lesson plans to try and extend it beyond just the things that we were given to try and do within those models. Having the time to sit down and to plan....

Bonnie also described time in terms of opportunities to practice. Her comment about the time to "practice it gave some perspective that made it easier to actually do it in the classroom even though at the time when I looked at it, Do we really have to do this with a

bunch of adults?" was telling of her personal ideas about practicing a teaching technique or lesson. She also stated that for a "teacher to be able consider changes in their practice it is easier and more likely to happen sooner if they have the training and the time to plan and incorporate those changes."

Renee's description of the difference between one year and two years of involvement in PD provided a view of the value she placed on long-term time investment for teacher learning. She said:

> There was a difference between year one and year two—year one, it was—well, not even year one. I would say the first week of year one, I wanted to stay with the familiar—like Todd (school peer) or Bonnie (PD peer), cuz they were familiar to me.… I feel like those concepts became clearer to me in our professional development the second year.

Speaking of other effective PD she had attended, Bonnie said, "They both provided the time and opportunity to wrap my mind around the concept and figure out how to implement it immediately and to continue to have opportunities address and modify the concepts and implementation."

General description. The conceptual understanding of "wrapping my mind around" a particular concept can be generalized to the need for teachers to understand the purpose for pedagogical practices. Bonnie provided numerous examples of ways she needed to have time to understand the concept of the PD being provided, but would, almost, simultaneously identify her desire to have practical application time in order to implement a module or teaching practice.

Renee's examples focused more globally on working with peers and the idea of long-term interaction with those peers for her to realize conceptual or practical ideas. The

combination of both teachers' responses provide evidence of the need to identify and support the time needed to develop conceptual changes to teaching practice and the opportunities to engage in implementation trials of practical teaching techniques.

Interpretive commentary. An excerpt from Bonnie's interview provides a helpful picture of the influence time can have for teachers appropriating new concepts and practices from PD. She said:

> There was initial planning after training and follow up time after for continued planning and incorporation. It made it easier to start making changes and trying immediately rather than finding the time amongst everything else you are trying to do. It often keeps it from getting put off and added to the pile of good stuff you want to get back to and often never incorporate.

As teachers engage in learning experiences an immediate uptake of understanding may be expected; however, it appears that adult learners need increased amounts of cognitive and practical interaction in order to develop high levels of appropriation.

Influential Factor: Goal Alignment

Bonnie and Renee consistently expressed a purpose for teaching and the goals associated with their personal contribution to the learning and the lives of their students. Identification of their "real goal" or what "I wanted for my students" were ongoing components of the discussions about influences on their classroom instruction. Connecting the goals of the teachers with their PD experience appears to influence whether they will have the motivation to implement new types of instructional practice.

Particular description. Renee provides two particular examples of her goals and the alignment with PD being provided in the Cyber-Enabled Learning Project (Campbell et al., 2014a). Her comment was, "Well, I think I saw the value, and I saw that…." In

another instance she said, “I think maybe the light bulb turned on.” Both of these comments provide evidence of her goals connecting with the intent of the PD.

Linking the goals of teachers and the goals of the PD can also be seen in Bonnie’s statement:

> I want them to know and have all of that stuff, but my real goal is to teach them skills that they can use and apply in their real lives, whatever they do. The science skills and problem solving as a whole can lead them to how does it apply into their real life?

In this statement Bonnie identifies a larger goal than simply relaying content to science students. She looks at her role as a science teacher as a global and societal influence for scientifically literate individuals. The transformation of goals during Bonnie’s teaching career is evident by another statement she made in connection to her goals. She said:

> When I first started teaching, my goal and what I wanted was for the kids to be able to apply and be able to challenge themselves and achieve that higher thing. I was still trying to get them there by giving them a list of tasks of things to do and “Do what I tell you,” which was keeping [from this goal].

Understanding and connecting the goals of teachers with professional experiences seems to be a key to influencing the appropriation of new practices.

General description. The goals of teachers can be general or specific. In these case studies I found that our discussions focused on broad goals for students as global citizens. However, an underlying day-to-day sequence of goals was evident during my classroom observations. Renee and Bonnie exhibited goals of behavior and interaction with practical aspects of the classroom learning experience that were not discussed in our interviews. Goal alignment appeared to have aspects that were verbalized (what I want for my students) and aspects that were evident in classroom interactions but not

verbalized (day to day expectations). This separation aligns with the open coding themes of conceptual and practical inputs to ownership of new learning.

Interpretive commentary. The link between what a teacher does and the alignment of that action with their underlying goals is interesting. A specific example of this idea is that the purpose for Renee's assignments fundamentally changed through her PD experiences. Her statement was, "My point of the assignments is that they're gathering and learning information." This exemplified the need for PD opportunities to link with a teacher's personal goals for teaching. Renee's goals for teaching were defined in terms of how the PD fulfilled those purposes. This connecting of personal objectives or goals with the PD outcomes seems to be an important aspect of appropriating new ideas and practice.

Influential Factor: Support and Collaboration

Support from school-based administrators along with the collaboration of project-based or school colleagues appears to provide a necessary safety structure in attempting to incorporate new pedagogical practices. Positive support and collaboration systems seemed to empower Renee and Bonnie to persist in new conceptual ideas and practical techniques. The converse also appears to be accurate in that if a teacher is not supported or has limited peer collaboration a negative impact is likely to occur for the implementation of new pedagogical practices.

Particular description. Renee's conversations about support provided examples of administrative actions that empowered her to consider ways of enhancing her practice.

She said, “The principal. He’s a big proponent. If we can find the training, he’ll send it to us.” Bonnie’s experiences provided equal value in that when she felt supported by her administrator she was able to incorporate learning from PD. I found that both teachers had experienced supportive and challenging administrative support systems.

Support and collaboration within the practical tool arena focused on how to use a new idea. Renee exhibits this focus on practical supports in her discussion of Google Docs, “That additional support where I feel like I can manoeuvre around and understand, I would’ve never even known how to do a Google doc. I didn’t even know what that was when we started.” In another conversation about heat capacity Renee said, “I went and talked to Todd, and I was like, ‘Todd. How can I show—how would you test heat capacity?’ He said, ‘Like with water, it can hold heat longer’. It can keep that capacity longer.” This peer support discussion enabled Renee to return and implement a new way of teaching.

The following example from Bonnie introduces the idea of support systems with peers in a similar stage of development. She said:

> The same type of things seemed to be clicking that I was wanting to try and figure out and use more. The people that were trying to embrace it and use it more instead of just do what it was or the things that weren’t the same things as clicking with me. My interaction needed to be with other individuals who were at the same stage of teaching as I was.

This statement identifies a need for peer-based support that extends a learner’s understanding beyond the model provided by an expert.

Renee’s comments of how collaborative peers can continue to enhance her appropriation gives evidence to how supports are integral in the life of an educator.

"when you go to those places and they make you work with different people, you make those connections. All those people from [the Cyber-Enabled Learning Project], when I see them, there's immediate connection. 'Hey, what are you working on?' 'Hey, email me that,' or 'Hey…' Absolutely it provides a forum for that to happen."

A final comment on supportive collaboration came from Renee as she discussed her role in groups. Specifically, her opportunity to be a leader in collaborative teams allowed her opportunities to grow. She said, "different groupings, it allowed me to be the lead and it allowed me to the be the watcher. It allowed me to have different roles, I think, by switching it up. I think that can be really, really beneficial." Opportunities to consider new ideas and practices from new vantage points seems to have an enabling effects on the understanding and use of those ideas and practices.

General description. In general, PD that identifies and provides multiple supportive and collaborative experiences builds a community of learners that extends beyond the frame of the experience. The content of the support and collaboration also appears to extend beyond the scope of the PD concepts. Teachers who have support systems do not isolate those supports to include only the content where the support was developed. This type of support was explained as Renee described a school-based peer teacher who came into her class to ask about a math question and a management concern. Renee provided support and a collaborative environment for the peer teacher to work out her concern even though Renee was a science instructor.

Interpretive commentary. Providing avenues for teachers to incorporate new learning into their current practice can be fostered through a collaborative and positive

support system. Appropriating new ideas and practices seems to be helped by situations that develop a trusted community and supportive peers. Renee's example of this provides a general sense of building this supportive climate.

> I think I started to realize the point of these things is to help you be a better teacher…. I didn't get hung up so much on getting through everything, and part of that might have been because [the providers] said, "Do what you can do, but I'm not going to take your teaching away from you," kind of thing.

Building this environment of support is even more effective when there has been an opportunity of incorporating some change is followed by working with others who are trying similar things. This approach seems to contribute to attributes of ownership through showing a respect for teacher expertise. This respectful and supportive environment may contribute to a willingness to implement new practices.

Influential Factor: Synthesis and Understanding

The opportunity to reflect on practices *for* teaching and the purposes *of* teaching was evident in the conversations that I had with Bonnie and Renee. Renee provided more specific practice-based examples of conversations that she had with her school-based peers; however, when she spoke of Bonnie she described conceptual discussions. Renee appeared to find value in both a conceptual and a practical disposition when engaging in peer-based synthesis discussions of new pedagogical practices.

Particular description. In discussing PD opportunities to synthesize her understanding through writing, Renee said, "It made me think of some more things, that I kept writing as we were doing it.… If they can write about it, then I can go, "Oh, they understand." … I think that sometimes, it's more difficult to write what you know." For

Renee, it appeared that she needed additional supports to synthesize, personalize, and develop ownership of a new pedagogy. This was exemplified when she said:

> For me, my understanding—I get the concept, but writing it, I have a hard time with that. It helps me to share with each other and try it out, and then the concept becomes more concrete in my mind.

Another aspect of synthesis is to develop an understanding where previous knowledge was absent. Renee provides an example of being overwhelmed by the new concepts and practices when she said:

> I think about when it was first introduced and I was like, 'How're we gonna do this?' and then he let us take pictures and make our own right there. That was so valuable because some of the reasons I'm scared about introducing some things like this is because I don't know how to use them.

In addition to the challenge of new learning it seems helpful to have opportunities to discuss new ideas. Renee commented on this saying, "I think it's explaining, understanding or maybe not understanding and re-explaining. It happens when they go back and forth. If you're able to explain it, then you understand it."

Bonnie's description of synthesizing new practices helps to understand that practices need synthesizing opportunities based in experiences. She said, "The opportunity to develop why and how we were going to use new strategies made the professional development worthwhile and we really were able to incorporate it into our teaching and classrooms." This description links the appropriation of practices to actions. Alternatively, synthesizing concepts is exemplified by Renee's comment about providing time to work through her thinking about the concepts.

> I think, I just—I finally was thinking rather than just getting information, so providing that time [to think] helped. I also feel like [the providers] were sharing [their] information and thoughts about it, and then [they] were sharing articles and

> having us read and write our thoughts about it. I think it just made me think. I don't know, but it turned on.

General description. During the collection of interview data the influencing factor of synthesis and understanding was identified in two different ways. First, teachers appeared to develop deeper conceptual appropriation when synthesis occurred during writing activities. This occurred in the form of writing prompts during the Cyber-Enabled Learning Project. Second, discourse among peer groups seemed to develop practical methods of implementing new learning for teachers. When discussing teaching practices with peers Bonnie and Renee appeared to focus on the practical delivery of new learning from PD. Interestingly, when writing prompts were incorporated into the PD delivery Bonnie and Renee extended conceptual dialogue well beyond the writing prompt.

Interpretive commentary. Both types of synthesis and understanding practices appear to develop opportunities to own and thus appropriate instructional concepts and practices at higher levels. Synthesis and understanding opportunities are important for increasing teacher ownership of conceptual underpinnings and their associated practices. Synthesis of new ideas seems to be a key stage of developing ownership characteristics and ultimate acts of pedagogical appropriation.

Influential Factor: Engagement

Sustained engagement in learning new pedagogical practices appears to influence levels of persistence with new learning for teachers. In this study science teachers were engaged in PD that occurred over 2 years and included two 2-week summer sessions, two 3-day winter sessions, and monthly after school sessions creating ongoing and deep

connections to the concepts and practices being shared.

Particular description. Creating ongoing opportunities to interact with the philosophical purposes of PD offers teachers multiple exposures to make instructional and conceptual change. Additionally, developing experiences for teachers to engage in practical models of learning enables them to view science instruction from a learner perspective. Bonnie's comments highlight the value of ongoing professional learning over single-day PD sessions. Bonnie said:

> We were consistently meeting and getting feedback and thoughts from other people in different schools, trying it in different ways, made it easy to be consistently trying to actually utilize it and have the time to do it instead of it still being left in concept and wanting to, but not getting to it. Additional time and consistency over the two years made it easier to start doing something instead of just wanting to.

Renee described her experience with the Cyber-Enabled Learning Project in terms of being overwhelmed with the expectations but ultimately seeing value of the engagement expectations.

> The first time we came to [the Cyber-Enabled Learning sessions] and we were all like, "Whoa! I don't even know what those words mean." I mean, the first survey we had to take, I was like, "What have I got myself into? I don't even know what they're talking about." I do think that those experiences help me relate better to the kids, but I don't know if that's my personality that I'm thinking about that or if it's the professional development…then realizing that after the first year of PD with [the Cyber-enabled Project] I—we did it and we learned it….

In Renee's comments she also shared the value of engaging in experiences as learners, which creates empathy and understanding that is helpful when applying the knowledge in her classroom.

The culture developed with in a PD experience can positively influence the engagement opportunities. It also seems likely that when if teacher learners are deeply

engaged with learning activities, their willingness to persist and contribute to successful implementation of new pedagogies is improved. Bonnie's comment exemplifies this principle as she describes opportunities to meet with her colleagues. In her statement, Bonnie describes how she was able to identify new ways of making things work, but was not completely clear as to where the new knowledge originated.

> As we were bouncing ideas off and trying to make new things when we actually had our two weeks and our winter [PD], that we love working with each other 'cause we both were kind of catching onto the same things, at the same time to try and figure out how do we wanna make this work. It just fit. Also, meeting—you know, I can't remember what. Was it the pod meetings?

General description. Engagement in professional learning experiences exemplifies a shift from sitting through a PD session. Professional learning is an ongoing and long-term process that requires a learner to stay committed to the sustained acquisition and implementation of new concepts and practices. Historical models of PD have indicated that single episodic teacher learning to be incomplete or simply ineffective (Banilower et al., 2007; Brand & Moore, 2011; Guskey, 2003). Engagement in teacher learning should be developed through ongoing experiences and the creation of collaborative groups of teacher learners.

Interpretive commentary. Multiple exposures to new conceptual and practical ideas benefit teacher learners as evidenced by Bonnie's comments. She described how engaging with teachers from different schools and different districts created a teacher-learning environment were effective appropriation of new pedagogies could occur.

An interesting connection she helped develop was the idea that engagement can be fostered through a supportive community of learners. Developing a supportive and

collaborative environment has been previously described demonstrating a link between these two factors. Links between multiple influential factors provides added justification for use of activity theory as a theoretical framework in this investigation.

Influential Factor: Adaptation and Modification

The ability to adapt and make acceptable modifications is evident in the development and implementation of conceptual and practical tools. The factor of adaptation and modification appears to be strongly impacted through association with other influences. For example, the factor of support and collaboration seems to impact the ability of teachers to adapt a teaching practice. Even the application of the teaching practice can be mediated by the collaboration among peers. The integrated nature of these influential factors cannot be understated and must be considered as PD providers develop learning opportunities.

Particular description. Understanding the value of acceptable adaptation as described by Bonnie and Renee is important when attempting to recognize the influence that each factor has on a teacher's appropriation of new learning. Renee describes a sequence of learning and how adaptation was integral in her students application of instructional ideas she gained from the Cyber-Enabled Learning Project. She said:

> [S]o the first year I taught them Splice (software application from the PD). We did it in the spring when we did the ramps. I had two boys come in and say, 'Hey, can we film our French presentation? We have to do a news broadcast. Can we film it in your back room?' They put together Splice video for their French class, a news broadcast, in the back room. I think that kind of stuff opens up their mind…

Renee also stated that the "Cyber-Enabled Learning PD taught us how to do that, but I've

had to adapt for the level of student." These specific statements from Renee demonstrated a value for adaptation when practical tools are being incorporated into teaching.

Adaptations and modifications also occurred when I observed the use of conceptual tools. For example Bonnie described her conceptual understanding of the iterative process in the following way:

> One of the main things, is the iteration concept of taking it step-by-step. I haven't in my actual classroom necessarily done the same experiment (from the PD) through the three different steps, but I applied the concept of introducing it with a more modeled teacher approach, and then growing to the independence through teaching in concept.

She explained this further when she said, "I don't necessarily use it like I did the first two years because I see a different way to use it to meet my main goals and teach the big ideas that are needed for my kids." Bonnie's modification of the purposes shared during the PD appear to be guided by the contextual nature of her instruction. Each classroom is unique and each setting can benefit by appropriate modifications that meet the need within the individual learning environment.

Modification is not always a simple process and there are challenges to implementation. Bonnie described this when she said:

> I was forced to actually try it to realize that it does work. You have to modify things down, and some things were shortened from the way they were laid out, but it gave me the confidence that it can and does work.

This statement also provides evidence of multiple factors working together to influence the acceptance of a pedagogical practice. In this statement Bonnie indicates a connection to support and collaboration, synthesis and understanding, and other factors that will be introduced, value and practice.

Adaptation of learning from the PD appears to occur in a variety of ways. Bonnie provides two rich descriptions of how she sees conceptual and practical tool adaptation through her experienced in the Cyber-Enabled Learning PD.

> When I have professional developments that allow me as a teacher to take a concept and see how that fits within my classroom it helps me embrace it more as a teacher because it helps me to help the students do the same thing. Um, but when it is very structured, this is what you have to do, and this is how you have to do it and I am just training you on how to follow the directions, then that means that I need to do the same thing to my students, which is teaching my students how to follow directions rather than how to learn and embrace and use the information, but stick to the directions so it's making me as a teacher learn how to do something and intern do the same things for my students, instead of how can I personally utilize it as a teacher and how can I help my students utilize it for themselves.

The realization of how PD can impact the personal learning and practice of a teacher is evident in Bonnie's statement. It was interesting to see evidence that she was able to identify her shift in how she valued the PD experience, as evidenced in her next statement.

> [The PD] transitioned from something that I had to do to realizing that this is helping us train and use in practice a skill that we could apply and how it fit into our classrooms and curriculums. Because if I change to a different curriculum, I wouldn't use any of those modules. Since I've understood the concept of how the module thing works, I can apply that into a new curriculum.

Changing the use of a practice from a teacher training appears to be common and should be recognized when developing and delivering PD. Bonnie's next statement gives evidence that conceptual tools are changed and mediated over time. She said, "I don't necessarily use it like I did the first two years because I see a different way to use it to meet my main goals and teach the big ideas that are needed for my kids."

General description. In the comments made by Bonnie and Renee, it was noticed

that adaptive change was a necessary component of implementation for the Cyber-Enabled Learning PD. Modification of concepts and practices occurred in many of the teachers' sustained improvements. Developing an understanding of the key principles and concepts contained in the PD appeared to be more valuable than the utility of the specific modules (content) shared during the sessions. In this research the adaptive nature of a PD experience seemed to influence a teacher's ability and desire to appropriate new ideas and practices.

Interpretive commentary. Understanding how acceptable adaptation and modification occurs is a needed area of continued research. Data collected as part of this study suggest that opportunity to develop acceptable adaptations from PD increases the likelihood of effective classroom implementation of key principles. Additionally, contextual variations within classrooms often require a teacher to develop modifications. Therefore, using this factor of adaptation in PD development could benefit teachers in developing localized professional expertise that exceeds the effectiveness of instructions from an external expert.

Influential Factor: Relevancy and Value

Educators enter professional learning experiences with a variety of expectations. In this study the data suggests that many teachers include relevancy and value for their students as an important expectation of PD. Clarifying the relevancy for student learners creates purpose for PD attendees. In this study I saw evidence of value being developed by Bonnie and Renee as well as value being overtly discussed by PD providers.

Particular description. Developing relevancy seems to occur with the individual

and from the PD experience. Renee described how she personally experienced the value of a software application shared at the Cyber-Enabled Learning PD. She commented:

> When I practiced Splice (software application) in our PD, I used [it and] we took some pictures and we made videos, but I went home and I made a video of my family vacation. I was like, "This is awesome," and I got it.

This concept of relevancy was also evident in an earlier discussion about students using Splice for application in French class. Bonnie was more succinct in her statement about value when she said, "If I don't see value for the student then I will not do it."

Another component of the data that was collected in this study was the persistence that teachers would give to a concept or practice if they perceived it as valuable to their pedagogy. For example, Bonnie said. "If I value the concept enough I will make it work practically in my class. If I'm not sold on the idea I worry about the practical implementation aspects." Bonnie also said, "Good professional development that makes me want to go and get it is something that I can see is useful and relevant for me to start using in my classroom, whether it's just a technique or concept-type things."

General description. Generally two aspects of relevancy and value were identified in the course of this study. First, personal relevancy for teachers and students is a necessary aspect that leads to higher levels of appropriation. Second, the willingness of a teacher to invest in and persist in the use of a practice is linked to the value they see in both the conceptual purpose and the practicality of the tool. Relevancy and value gives purpose to new learning and creates a belief for acting and thinking new instructional ways.

Interpretive commentary. The willingness of teachers to invest in the supports

and efforts for successful implementation seems to be grounded in the value they place on the conceptual purpose for that practice. In thinking about this, I see opportunities for teachers to contribute to the success of any new innovation as long as relevancy and value are established. If teachers do not see value their support of any new concept or practice will be limited and thus success of the innovation will be in question.

Influential Factor: Practicing

The factor of practice can be understood as opportunities to process new conceptual and practical tools. Practice is also consistently linked with time. In order to have practice with conceptual tools a teacher needs processing time. Likewise if a teacher is to develop practical tools, such as a software application, time is needed to develop its use. In this study practice occurred during the PD sessions and when teachers returned to their classroom or homes.

Particular description. As part of the Cyber-Enabled Learning PD participating teachers were asked to develop a science experience that ramped into or out of presented learning modules. Teachers then shared these experiences with their peers in a role-play style practice. Bonnie was not thrilled with this initially but as you can see from her comments her view of teacher practice experiences changed.

> I remember the time that we actually had to pretend to teach the whole lesson. [I thought] that's a waste of time, but to practice it gave some perspective that made it easier to actually do it in the classroom even though at the time when I looked at it, 'Do we really have to do this with a bunch of adults?' If we had practiced it, that gave us a sense of starting to do it before we ended up in the classroom and having time to write more lesson plans made it easier to not take something that I thought was good and wanted to try and do but to make it easier to start doing.

Bonnie's description establishes the idea that teachers learn in similar ways to

students. In this way, experiencing the learning is more valuable than talking about it. Direct instruction in science classrooms is a perfect example of teaching "for" science instead of experiencing science. Renee's comment also supports the idea that teachers need to experience learning. She said, "Well, like that silent sustained writing and learning how to use Google Docs. I actually had to do it!"

The connection of practice to ownership was evident in the following comment from Renee. She said:

> I'm positive I've learned it from professional—I mean, obviously we've been taught, and so I've learned it from professional development, where you take a minute and explain things. We did that with [the Cyber-Enabled Learning Project], I mean, and I see the value in that, maybe because I'm one of the ones that has a harder time explaining sometimes.

Renee's description of practice was embedded in the idea that she had opportunities to explain things to her peers and in doing this she understood better. Even though the explanation was challenging, she saw that it assisted her in understanding the concepts.

Another comment from Renee continues to demonstrate the value of adults learning through practice. In reflecting about the PD she said:

> Whoa, can we do that? Had he just shown that, it might not have been as effective, but when he had us doing it and then we had to test and come up with different things, I was like, oh. I don't know if that's because I'm more of a hands-on person, but I just feel like if you understand it, if you've done it and you understand it, then you're more likely to take it back and do it in your class. I mean, I never used a Google Doc ever before or even the calendar. I mean, I didn't understand and use that, and now I'm using it all the time. If I experience it, I'll go ahead and do it.

This description of appropriating new learning into consistent use demonstrates that adult learners should have opportunities to practice what they are expected to use within the classroom. Without practice, appropriation could easily transition to abandonment.

In Bonnie's description of her ability to develop a conceptual shift in her teaching, she connects a discussion of practice. She said, "That's been huge, when it's a concept shift or a shift that's going to change a lot of what I actually do day to day. The time to practice it and then follow up as you've got some of that experience…." In this conversation, Bonnie included singular practice opportunities but also connected another factor, namely ongoing engagement with the thinking and experience.

General description. Singular practice does not appear to be sufficient to effect high levels of appropriation. Bonnie and Renee identified the need to return to practice opportunities multiple times following an introductory experience. The use of monthly Pod meetings throughout the 2 years of PD provided multiple exposures to practice specific practical tools such as Google Docs. These ongoing Pod meetings also provided opportunities to practice conceptual thought in discourse with project peers and in writing through responses to targeted prompts. The opportunity to practice both conceptual and practical tool development appears to positively influence levels of appropriation and implementation.

Interpretive commentary. In this discussion practice has been understood to be more than a simple repetition of a skill. Practice includes opportunities to process conceptual ideas as well as experiment with practical application of techniques. It seems that this processing opportunity extends a teachers ability to appropriate far beyond a simple replication. Increasing the capability of learning from PD beyond a simple fidelity mindset may hold unlimited possibilities for educator effectiveness.

Influential Factors Conversation

Insight to how the Cyber-Enabled Learning Project impacted the appropriation of teacher learning is best described from a comment made by Bonnie in our fourth conversation. Her comment demonstrates the connected nature of the eight influential factors described in this chapter. She said it best:

> In the [project] we got training on the concept and then had time to develop our understanding and ways to implement it into our own classrooms. We had time to consider, 'How do we think?' and then develop what works. I also think we had time to consider what we value.

In a member checking written document sent by Bonnie, she extended her statement about the nature of appropriation from the Cyber-Enabled Learning Project PD, saying:

> The PD provided the time and opportunity to wrap my mind around the concept and figure out how to implement it immediately and to continue to have opportunities address and modify the concepts and implementation. This was very unusual as most opportunities only allow for introduction to the concepts or teaching practices and then you are left to figure out how it fits into what you do and hopefully find the time to work out the practical implementation. In those cases, it is really dependent on how quick and easy it is to use and often it gets set aside and is never returned to.

As I considered these eight influential factors I returned to the emergent themes of conceptual tools, practical tools, and ownership. From the connected nature of each of the factors I can see how factors mediate the themes. In turn each theme mediates an understanding and use of the factor. Figure 5 provides a visual representation of this discussion. A teacher thinking about a recently introduced concept is an example of this process of mediation. His understanding of this concept is influenced by the practice or supported experiences. When this same teacher reflects on the concept, its value,

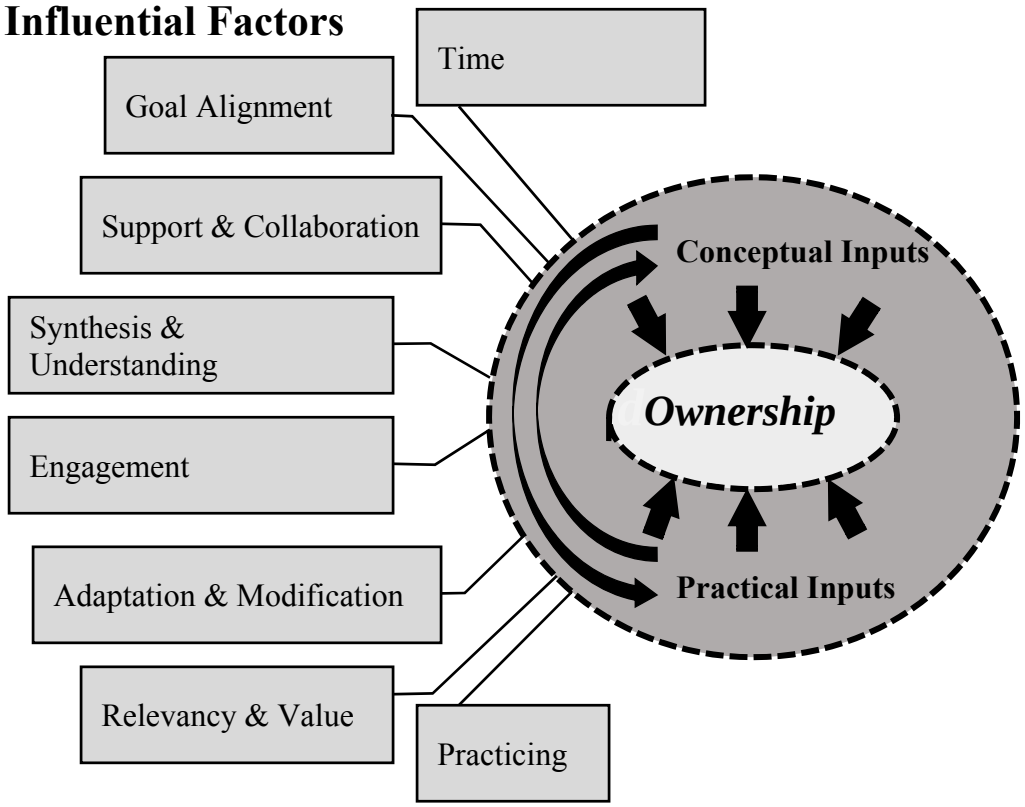

Figure 5. Factors influencing conceptual and practical input on ownership.

influences the amount of practice he is willing to contribute to furthering his understanding. Multiple factors appear to interact with the themes in this mediated fashion. Therefore, it seems helpful to investigate ways in which PD providers can develop avenues for teacher to utilize each of these factors during professional learning.

Summary of Axial Coding

During the axial coding analysis eight influential factors were identified as having impact on the three themes that emerged from the open coding analysis. These eight factors appear to influence each theme in unique ways. An interpretation of each factor is

provided in Table 14. Each factor appears to influence conceptual and practical understandings in varying degrees, based on individual contexts and experiences.

Tertiary Analysis: Selective Coding

The connected nature of the themes and factors has consistently presented itself throughout the analyses. In selective coding, I, as the researcher traveled down a path of developing explanations and propositions of the phenomenon (Merriam, 2009). Factors

Table 14

Influential Factor Interpretations

Influential factor	Researcher interpretations
Time	Time appears to be essential in both the conceptual development of why teachers perform in certain ways and the practical development seen through what is implemented.
Goal alignment	A purpose for investing in a particular practice was evident in many of the statements of the participants. However, it seems that goal alignment was rooted within a conceptual mindset and influenced other factors as well as the identified themes.
Support & collaboration	Support and collaboration was grounded in collegial peer and administrative interactions. Bonnie and Renee looked to peers and administrators to understand practical ways of teaching and to feel capable of instructing in new and novel ways.
Synthesis and understanding	This theme is closely connected to the factor of time, in that opportunities to synthesis and understand need time. Synthesis and understanding link to conceptual inputs with opportunities to consider purposes of instruction. This factor connects to practices by offering experience in application of strategies and methods.
Engagement	Evidence of engagement was described in terms of sustained connections to the PD in both conceptual and practical ways.
Adaptation an modification	Teachers who had opportunities to adapt and modify both their understanding and the method they used within their classroom exhibited attributes of owning new ways of thinking and doing.
Relevancy and value	Relevancy and value were critical to a Bonnie and Renee's development of goal alignment. If there was not a personal connection of value for their student's appropriation did not occur.
Practicing	Practice is related to engagement, however, practice focused more overtly on the use of practical tools. Interestingly, I found practice in the thinking about concepts was extremely valuable, although not necessarily identifiable to the teacher-learner.

appeared to influence conceptual and practical inputs, which resulted in the development of ownership characteristics (see Figure 6). This ownership seemed to drive the level of appropriating new learning from teacher training. Ownership also seemed to create persistence efforts within teachers to incorporate factors in their learning and teaching. In the case studies, both teachers provided examples of being more willing to adapt and modify if they first valued ownership of concept. However, starting with a conceptual focus may be ill advised due to the evidence that practical features from the Cyber-Enabled Learning Project also created ownership characteristics.

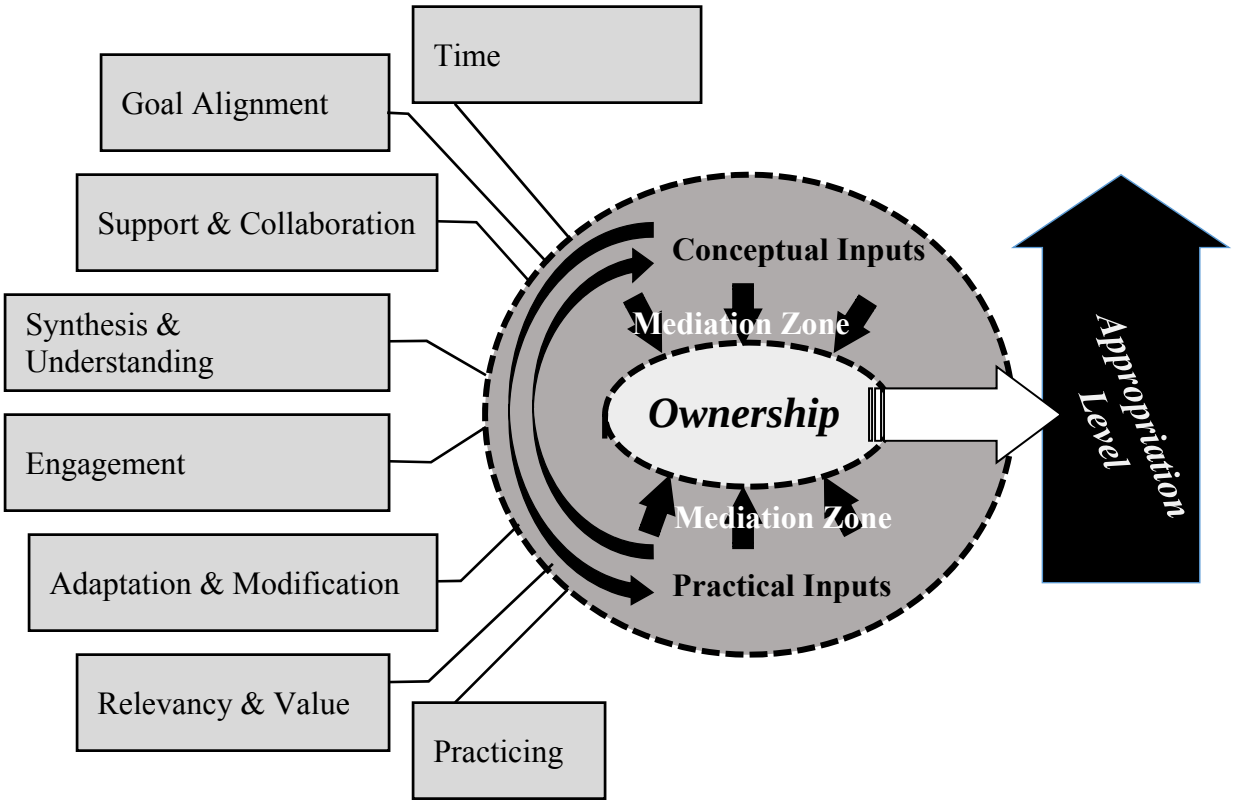

Figure 6. Appropriation features.

During the tertiary analysis of the connections between each of the influential features and the themes a connected mediation link was observed. Each line of influence seemed to be mediated by both concept and practice. In turn conceptual understanding and practical application had reciprocal influences on each other resulting in the central theme of ownership. As this understanding of ownership continued to develop its linkage to appropriation was solidified. Each appropriation level could be understood in degrees of ownership that was ultimately developed through increasing confidence in a conceptually or practically based tool.

Features of appropriation as described by Grossman and colleagues (1999) appeared to align in many ways with other researchers' discussions regarding ownership of professional practice (Chee & Mehrotra, 2012; Penuel & Gallagher, 2009). Evidences of ownership attributes have also been observed during this study. The connection of ownership and appropriation is not synonymous and should therefore be considered in terms of how ownership, a personal possession stance, contributes to appropriation, the possession, and delivery of instructional thought and practice. The influential and interconnected nature of appropriating new pedagogy from PD can be further understood when reviewing Figure 6. The conceptual framework of activity theory (Grossman et al., 1999) provided a method for this grounded theory approach to identify the connectedness of the characteristics of ownership and appropriation form professional experiences.

Summary of Selective Coding

The selective coding process yielded an informed understanding of the mediational influence that factors have on the identified themes. Each factor, in each

description provided by Bonnie or Renee appeared to have an impact on how a conceptual tool or practical tool developed attributes of ownership. It was also apparent that factors were mediated by other factors in addition to the mediational influence of conceptual and practical inputs. Levels of impact appear to be connected to how these contextual inputs are precieved by each individual teacher-learner. Ultimately, the attributes of ownership that are developed through the mediation zone contribute to the level of appropriation exhibited by the learner (see Figure 6). Attributes of ownership and levels of appropriation are seen as separate. However, the development of greater ownership positively contributes to appropriation at higher levels.

CHAPTER V

DISCUSSION

In this study, I investigated how teachers can be influenced to appropriate new pedagogical tools and the role that conceptual and practical tools play in this appropriation through an NSF supported science educator learning project (Campbell et al., 2014b). This chapter will summarize my findings in the context of my research questions. In the previous chapter, I discussed an analysis of both quantitative and qualitative data that will now be used to answer the research questions first introduced in Chapter I. Aspects of appropriation will be discussed in terms of the themes and factors identified during the observations and interview analysis. Research findings will then be related to current literature discussed in Chapter II. Finally, limitations of this study and future research will be discussed.

Purpose of Study

Improvement of student learning is the premise of almost all professional development efforts appears. Therefore, gathering assessment scores to measure impact of PD is a natural practice. It is often assumed that PD participation automatically results in the implementation of PD learning within classrooms. Additionally, national efforts to improve scientific literacy have resulted in initiatives to improve to science education in our nation's classrooms. This study informs the developers, providers, and participants of professional development within science classrooms by illuminating the factors that influence the appropriation of pedagogical concepts and practices.

Research Questions

In this investigation, I sought to better understand teacher appropriation from PD experiences. Specifically, for participating science teachers whose students demonstrate increased achievement when compared to students of nonparticipating teachers.

1. How and to what extent are teachers influenced to appropriate pedagogical tools from professional development?

2. What role do conceptual and practical pedagogical tools play in the appropriation of instruction strategies associated with professional development?

To answer these questions a [quan → QUAL] design (Christensen et al., 2011) was employed to quantitatively inform a purposeful selection (Creswell & Clark, 2007) of teachers who had participated in the Cyber-Enabled Learning Project. Upon selection, two teachers were invited to participate in a series of five classroom observations with paired interviews and ongoing member checking (Merriam, 2009) opportunities.

Initially, I predicted that students of teachers who participated in a 2-year Cyber-Enabled Learning project PD (Campbell et al., 2014a) would outperform, as measured by state science achievement tests, students of teachers who did not participate. I also thought that the phenomena of teacher implementation of principles and practices provided in PD could be identified using an activity theory framework (Bourke et al., 2013). With these questions and hypotheses in mind I will now summarize the findings from this study.

In order to achieve the intended purposes of PD, the educational community must better understand the factors that influence how teacher adapt, adopt, and abandon new

learning. Valencia and colleagues (2006) provided evidence that teachers who experience structured curriculum programs did not necessarily experience increased knowledge gains. Some teachers experience PD by choice others by school mandate, however, this mixed methods study along with other research suggests that if the PD focuses on a structured approach little or no attributes of ownership are developed, which contribute to the capacity of teachers to meet the needs of learners (Chee & Mehrotra, 2012; Valencia et al., 2006). Within this study both a quantitative outcome and qualitative data were connected in order to identify how appropriation levels might impact student learning. In the current educational climate this connection between assessment and PD implementation is critical. The findings from this study inform the decision making process for those allocating the investments for continued professional development. Without informed decision making educators will continue providing experiences that seem good but may in reality produce little improvement in instruction or student learning.

The data from this study provides and understanding of ownership attributes that can be connected to particular content knowledge, experience, or context. These ownership attributes appear to contribute to increasing appropriation levels. Using activity theory as a theoretical framework provided a method of considering the meditational influence that occurs in a situation. It would seem that attributes of ownership found within this study would influence the object with activity theory as discussed by Engeström (2001), Leont'ev (1981), and Vygotsky (1978, 1987). Understanding the connection of attributes of ownership for particular concepts or

practices might lead to developing pathways for teacher learning that have been elusive.

Findings

The mediated influence of multiple factors on appropriation was clarified trough examination of classroom observations, teacher interviews, member-checking responses, and personal reflection. In instances of ownership (Chee & Mehrotra, 2012; Penuel & Gallagher, 2009), adaptation (Shymansky et al., 2012), ongoing PD (Davis, 2003), and support systems (Bausmith & Barry, 2011; Shymansky et al., 2012; Visio et al., 2008) there is a clear alignment with current literature. It is expected that researchers investigating similar phenomenon would identify comparable factors that influence appropriation. This section provides insight for PD developers and providers in terms of essential factors that are likely to lead to higher levels of appropriation.

Comments and thoughts shared by the two cases, Bonnie and Renee, suggest that factors impacting teachers' use of new pedagogies combine in multiple ways. This combinational influence is constantly adjusting and modifying based on conceptual ideas and practical techniques. PD providers may need to consider this meditational zone during teacher development sessions in order to develop greater degrees of appropriation as researchers describe (Grossman et al., 1999; Penuel & Gallagher, 2009; Penuel & Means, 2004; Shymansky et al., 2012). The remainder of this section will be devoted to the explanation of the key aspects that influence appropriation found in this study.

Themes, Factors, Ownership → Appropriation

The data from this study can be categorized into three main areas of investigation,

namely open coded emergent themes, axial coded influential factors, and selectively identified attributes of ownership, which all have influence on the level of appropriation a teacher might exhibit. Three themes became evident during the initial open coding of the data and will now be discussed.

- *Conceptual inputs*—The notion of conceptual or philosophies of instructional purpose are central to this theme. The participants demonstrated this through a discussion about their purposes for teaching as well as when they described new pedagogies. Conceptual inputs or tools are informed principles that influence instruction and may include value statements, purposes, and goals that give reason for a particular instructional practice (Hardy, 2013; Rogers et al., 2010). Conceptual inputs are often unseen aspects of instruction that require articulation by PD providers and participating teachers to clarify the purposes for learning experiences.
- *Practical inputs*—Practical inputs or tools can be understood as applied techniques, strategies, activities, or ways of teaching centered on what is done in the classroom (Hardy, 2013; Rogers et al., 2010; Yamagata-Lynch & Haudenschild, 2006). These methods are the physical tools of instruction. The participants demonstrated practical tools through descriptions of software applications, lesson plans, or particular teaching modules. Historically, these practical inputs overshadow conceptual inputs in PD resulting in a "follow the steps" *for* instruction approach to teaching. Providers might consider greater

focus on opportunities to acquire knowledge *of* teaching science (Bourke et al., 2013).

- *Ownership*—Attributes of ownership included personalization and internalization of both concepts and practices. This theme appeared to be connected to both concepts and practices through comments from the participants such as; "I wanted my students to…" or "My intent was…" PD providers should consider ownership as a demonstration of internalization of both the concept or idea and the skill to implement a practice. Chee and Mehrotra (2012), and Penuel and Gallagher (2009) have previously discussed the attributes of ownership in association with appropriation. However, the inclusion of both conceptual and practical tools is limited in the literature and may be an avenue for research to investigate and gather further evidence of ways to develop ownership attributes.

These three emergent themes created a structure for further investigation and along with other components of the analysis are depicted in Figure 7. Structuring these themes led to asking, what characteristics, attributes, or factors seem to influence a teacher's appropriation? The analyses then focused on the factors that appeared to influence the development of conceptual and practical ownership (see Figure 7).

Influential factors can be numerous and are often individualized. However, in this study eight influential factors were evident in the data. Each factor should be considered as a necessary element of effective PD.

Source	*Initial (Open) Coding*	*Secondary (Axial) Coding*	*Tertiary (Selective) Coding*
Category	**Emergent Themes**	**Influential Factors**	**Propositions**
Aspects of Evidence	Conceptual Tool Input	Time	Mediation develops attributes of ownership which influence levels of appropriation
		Goal Alignment	
		Support & Collaboration	
	Practical Tool Input	Synthesis & Understanding	
		Engagement	
	Ownership	Adaptation & Modification	
		Relevancy & Value	
		Practice	

Figure 7. Sources, categories, and evidence of influences on appropriation.

- *Time*—This factor is necessary for both conceptual and practical tool appropriation. When time is invested in the conceptual understanding of a pedagogical idea it is often centered on self- or peer-reflective opportunities. Conversely, development of a practice or method seems to require multiple implementation trials to internalize a teaching technique. As teachers engage in PD it appears that they need increased amounts of cognitive and practical interaction (time) in order to develop high levels of appropriation
- *Goal alignment*—In this study the participants were clear that aligning a personal goal to the learning from PD was essential in connecting the ideas and concepts presented to what they actually did in the classroom. The goals

of teachers are often articulated in discussions through global statements; however, practical goals are evident in the day-to-day classroom practices. In order for PD to be effective purposeful alignment of both large and specific teacher-owned goals should be developed.

- *Support and collaboration*—Evidence from this study would indicate that support is more of a collaborative engagement with peers and educational leaders rather than simply a willingness to allow a teacher to test an idea. Support and collaboration also seem to be associated with both conceptual tool and practical tool development. Support systems that encourage new ways of thinking about learning can be linked to the pedagogical changes that might be possible for a teacher. However, collaboration in the development of new practices is essential for the possibility of change to occur. Bausmith and Barry (2011) described this factor in terms of communities of practice, as have other researchers (Shymansky et al., 2012; Visio et al., 2008).
- *Synthesis and understanding*—This factor reflects the idea discussed by Bourke and colleagues (2013) that the reflection on practices *for* teaching and the purposes *of* teaching are necessary for instructional changes to take place. These synthesizing opportunities are important for increasing the attributes of ownership of both the practice and the purpose for the practice.
- *Engagement*—Sustained engagement in learning a new pedagogical practice seems to influence the level of appropriation through creating deep connections to the concepts and practices. This factor was identified as the

participating teachers made reflections on their initial reactions to new ideas in comparison with their current views. Davis (2003) discussed similar influences when explaining active learning experiences. Developing engagement in both the concept and the practice seems to be linked to the factor of time.

- *Adaptation and modification*—The influence of being able to make acceptable modification is evident in how conceptual and practical tools are developed. The act of adaptation is central to the development of ownership as evidenced by the participant's dialogue of "their" instruction and should be part of PD experiences if high appropriation is desired. Without this key factor the mediation towards ownership may be difficult. Shymansky and colleagues (2012) discussed the differences of adaptation and adoption when describing ways of connecting and interpreting science across the curriculum.
- *Relevancy and value*—This factor gives purpose for investment actions of a teacher-learner. Relevancy and value from the perspective of the teacher creates an positive influential factor that will likely impact both conceptual and practical understandings in addition to developing a willingness to make appropriate adaptations, invest time, and persist in challenging endeavors.
- *Practice*—This factor is a natural extension of value place on a new understanding by an individual. If value is present then teachers will invest in the practice necessary to succeed. This persistence in practice often results in the success of a questionable technique due to the context and the effort of the

teacher. Another component of practice has been introduced as educative curriculum (Davis & Krajcik, 2005). Educative curriculum allows teacher learners to engage in the learning task in similar cognitive ways to their students.

The meditational connection of these factors influence how conceptual and practical inputs affect attributes of ownership (see Figure 6). These eight factors provide insight as to the influences within PD that impact appropriation in response to the study's research questions. PD providers can increase effectiveness of higher levels of appropriation by considering how to incorporate each of these factors in teacher learning experiences.

Internalization, Ownership, and Appropriation

The case studies demonstrated that science teachers are likely to be more willing and capable of integrating new practices when they have a degree of ownership in the success of the practice. This may indicate a need for PD developers and providers to reevaluate fidelity of implementation measures (Lee & Chue, 2011). Internalization and ownership also leads to higher levels of appropriation when teachers are able to understand the conceptual purposes for a practice. Such as developing a purposeful, conceptual, practical, and individualized understanding of the practices of science within NGSS (2013) in order to be capable of exhibiting the practices within classroom interactions. This ownership results in greater degrees of persistence toward the success of a pedagogical practice (Banilower et al., 2007; Chee & Mehrotra, 2012).

Recommendations

Researchers and PD providers inherently want teacher learning to improve the opportunities and learning experiences of students. However, it is critical that efforts be based on research that accounts for the multiple influences that impact teacher practice. The results of this study suggest that teachers need experiences in PD that foster development of eight influential factors in order for principled adaptation to occur (Penuel & Gallagher, 2009). Rowan and Miller (2007) discussed how programmed approaches conflict with adaptive approaches within the literature. The findings of the current study support an adaptive approach where teachers develop ownership attributes allowing for contextual adaptation within conceptual boundaries. Additional researchers support the incorporation of adaptation within PD delivery (Fogleman et al., 2011; Forbes, 2013).

Instructional practice has also been shown to influence opportunities to make localized adjustments to teaching techniques (Penuel & Gallagher, 2009). In this way teachers are able to take conceptual understanding and adapt specific teaching practices based on contextual learner need. Rowan and Miller's (2007) description of adaptive strategies creates instructional innovations based on the need to accommodate for local contexts. Curricular adaptations seem to be an integral part of PD delivery allowing participants to invest in the effective implementation of cooperatively created instruction as stated by Shymansky and colleagues (2012). In this study localized adaptation is linked to the factors of adaptation and modification, support and collaboration, and practicing.

Van Duzor (2011) provided a description of how teacher-learning experiences increased the motivation of teachers to implement new PD concepts. The impact of motivation on the appropriation of pedagogy from PD is evident in this study when one considers how the teachers responded to the factor of relevancy and value. This factor of relevancy and value created motivational purposes for implementing new ideas and practices. Motivation to persist in a particular teaching practice is also a key aspect of ownership. The attachments of personal ownership to adaptation levels as well as community development with adaptation also link with the idea of motivation (Forbes, 2013; Penuel & Gallagher, 2009).

The participating teachers described beliefs about the efficacy and ability to use a new conceptual or practical tool in terms of relevancy and value. Luft (2001) discussed the complexity of implementing learning from PD in terms of science teacher construction of practices and beliefs. This connection would suggest that both conceptual understanding (ideas and beliefs) and practices are central in the appropriation of pedagogical strategies.

Another strongly developed connection with the literature and this study is the need to have teachers sustain involvement over time in professional learning experiences. Multiple researchers have discussed the need to have PD sustained over time (Banilower et al., 2007; Supovitz & Turner, 2000). As part of this study extended time of engagement and sustained depth of investment were exhibited as key factors in developing higher levels of appropriation.

In summary, those developing, providing, and experiencing PD for science

teachers should consider how the eight influential factors described in this study can be incorporated the learning opportunities provided to teachers. Each learning context is unique and must be evaluated on the basis those participating in order to recognize the meditational influence that each of these factors have on one another and on the conceptual and practical inputs of pedagogical appropriation. Further investigation on these factors is clearly needed. However, the following general principles from this research should be considered for those currently providing PD.

- Use of an adaptive approach in PD appears to increase appropriation of new and effective instruction (Penuel & Gallagher, 2009; Rowan & Miller, 2007).
- Experiencing new ideas and practices from a variety of learning roles improves attributes of ownership and ultimate appropriation of those ideas and practices.
- Development of concepts and purposes for learning modules is more influential on future appropriation than knowing the steps of instruction (van Driel et al., 2001).
- Adult learners need increased amounts of time to engage cognitively and practically than they currently experience (Leko & Brownell, 2011).

Limitations of the Study

The qualitative nature and small number of participants included in this study create limitations on the generalizability of findings for this research; however, the same small number of participants strengthens the depth and richness of the investigation

through thick description of classroom practice (Merriam, 2009). Multiple personal observations and interviews enabled me to strengthen a trusted relationship with these teachers, where, they openly shared developing ideas, unrehearsed thoughts, and question about appropriation of conceptual and practical pedagogical tools.

A second limitation of the study was that I was both a provider and developer of the Cyber-Enabled Learning Project provided to these teachers (Campbell et al., 2014b; Longhurst et al., 2015). I believe this connectedness with the content, delivery, and participants enabled me to access concepts that may have been overlooked by an external investigator. My connected relationship to the participants and the project may also have created a desire of the participants to "search for the right" answer during the interview sessions. Multiple paired multiple engagement opportunities were intended to develop a comfortable setting and minimize the concern of participants searching for the "right" answer.

A third limitation of the study was the possibility that using a particularistic (Merriam, 2009) method of investigation may lead to a singular view of the phenomenon. This is concern is connected to the first limitation in that a small number of participants and a focused view has the potential to yield biased interpretations. As in all qualitative work, this limitation has been identified and thus it is intended that its impact on the study will be minimized.

Future Research

In this study I have presented evidence that appropriation of learning experienced

in PD settings can be influenced by multiple factors. These factors are based in two specific areas, namely conceptual and practical ways of understanding new pedagogical strategies. When conceptual and practical tools are mediated by these factors attributes of ownership are developed that link to the appropriation of new pedagogies. Therefore, further research investigating how these factors can be developed and supported within a PD setting has merit.

Additional research in the area of internalization or ownership of new instructional practices would also be a valuable investment. In the current educational climate of scripted instruction this internalization and ownership may be challenged. The data from this study would suggest that it might be necessary to reconsider the assessment of teachers in terms of strict fidelity measures and develop instruments that illuminate how teachers develop ownership attributes. If researchers are able to better understand how a teacher develops attributes of ownership, then PD providers may have access to the knowledge that develops teacher-learning experiences fostering greater internalization and appropriation of new strategies. Visio and colleagues (2008) have discussed how the nation's reformed vision of science instruction requires new expectations of teachers to teach in ways they have never used before. Helping teachers acquire new methods and concepts of teaching science requires more than a discussion in a PD experience. Developing ownership attributes of these new ideas will require an understanding of how teachers internalizing of attributes can be developed that lead to appropriating new ideas of instruction.

Further research on how attributes of instructional internalization from PD can be

realized is necessary. These investigations should guide our development and delivery of teacher learning experiences. Borko (2004) called for continued research on PD in order to further the understanding of the impacts it has on instructional practice. As an educational community, it is important to extend our knowledge of this institutionalized practice for improving teacher instruction.

Conclusion

Numerous researchers have discussed the factors that should be present when designing professional learning experiences (Dane & Schneider, 1998; Grossman et al., 1999; Marra et al., 2011; Rogers et al., 2007; Penuel & Gallagher, 2009; Rowan & Miller, 2007; Van Duzor, 2011). This study provides evidence that, if appropriated, can improve our understanding and delivery of professional learning experiences. It also adds to the literature of instructional appropriation gained in PD by linking outcomes of increased student achievement with previously hidden aspects of conceptual and practical pedagogical appropriation.

In an era of national science reforms including the NGSS (2013), it is important that PD providers develop experiences for science teachers with an understanding of the factors that influence the appropriation of reformed practices. Enhancing the appropriation of science instructional strategies is an important goal for science educators and the entire educational community if we are to realize the instructional goals described in reformed science teaching literature (National Research Council, 2012; NGSS, 2013). This focus on appropriation will allow educators to differentiate science learning

opportunities for all learners versus providing fidelity focused instruction that has limited adaptation for individual learners. Ongoing efforts to implement research-based curricula are a multi-billion-dollar investment in teacher learning that should produce positive learning outcomes for students (Desimone, Smith, & Ueno, 2006; Sawchuk, 2010). However, the impacts as seen in the literature are tenuous at best (Banilower et al., 2007; Brand & Moore, 2011; Guskey, 2003).

Decision makers should consider the levels of appropriation attained by teacher participants during professional learning experiences. These appropriation levels can be linked to student achievement of their students as demonstrated in this study. This reality provides a clear purpose for PD providers to incorporate the findings of this investigation in future PD development. Although effectiveness (Penuel & Gallagher, 2009) of PD is a challenging research area, this study and others can illuminate ways that educators can be supported in improving their practice.

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APPENDICES

Appendix A

Teacher Informational Letter

SCHOOL OF TEACHER EDUCATION AND LEADERSHIP

Dear Teacher,

As result of your participation in the Cyber-enabled Learning grant you previously participated in you have been identified as a possible participant in a subsequent research project. This current study through Utah State University seeks to understand the Appropriation of Professional Learning. We are excited share some basic information regarding the research process we will be utilizing.

If selected you will be invited to participate in five 45-minute classroom observations, five 30-minute interviews (paired with the observations), and opportunities to review and comment on collected data. Following the selection process you will be contacted to obtain Participant Informed Consent in the form of participant signatures and provided additional details regarding the investigation.

If you have any questions about our project, you may reach Dr. Jones or Mr. Longhurst using the information listed below.

Respectfully,

(435) 797-7093

Max L. Longhurst, PhD – Candidate
(435) 797-7093
max.longhurst@usu.edu
Utah State University

Suzanne H. Jones, PhD
(435) 797-1568
suzanne.jones@usu.edu
Utah State University

Appendix B

Informed Consent

UtahState University
School of Teacher Education and Leadership
2805 Old Main Hill
Logan UT 84322 - 2805
Telephone: (435) 797-7093

Page 1 of 2
USU IRB Approval: 7/22/2014
Approval Terminates: 7/21/2017
Protocol #5979
IRB Password Protected per IRB

INFORMED CONSENT

Adoption, Adaptation and Abandonment:
Appropriation of Science Education Professional Development Learning

Introduction/ Purpose Dr. Suzanne Jones in the School of Teacher Education and Leadership at Utah State University is conducting a research study to find out more about teacher professional learning. You have been asked to take part because of your participation in a professional development experience in connection to the Cyber-enabled Learning project. There will be approximately 3 total participants in this research. Max L. Longhurst will be conducting this research in connection with is doctoral dissertation and will by your main interaction with this investigation.

Procedures If you agree to be in this research study you will be asked to participate in five, 30-minute, semi-structured interviews during Fall 2014 academic year. These interviews will be paired with five connected classroom observations of approximately 45 minutes and may include written or journal responses for some questions. Additionally, you will be invited to review interview transcripts and observation data to ensure accuracy.

Risks There is minimal risk in participating in this research. Researchers will accommodate participant needs minimizing the limited risk of fatigue during the interview process. The only other foreseeable risk associated with this research could be the inadvertent loss of confidentiality; however measures have been put into place to secure the data and your confidentiality.

Benefits There may or may not be any direct benefit to you from these procedures. The investigators, however, may gain insight to the influential factors that lead to improvements in professional learning. An effective professional development model may also be explicated so that school systems across the state or nationally can benefit from what is learned.

Explanation & offer to answer questions Max L. Longhurst has explained this research study to you and answered your questions. If you have other questions or research-related problems, you may reach Dr. Suzanne H. Jones at (435) 797-1568 or suzanne.jones@usu.edu.

Voluntary nature of participation and right to withdraw without consequence Participation in research is entirely voluntary. You may refuse to participate or withdraw at any time without consequence or loss of benefits. You may be withdrawn from this study without your consent by the investigator if scheduling of observation or interviews create a negative burden on the investigation.

Confidentiality Research records will be kept confidential, consistent with federal and state regulations. Only the investigator and Max L. Longhurst will have access to the data, which will be kept in a locked file cabinet or on a password protected computer in a locked room. To protect your privacy, personal, identifiable information will be removed from study documents and replaced with a study identifier six months after the investigation. Identifying information will be stored separately from data

UtahState University
School of Teacher Education and Leadership
2805 Old Main Hill
Logan UT 84322 - 2805
Telephone: (435) 797-7093

INFORMED CONSENT
Adoption, Adaptation and Abandonment:
Appropriation of Science Education Professional Development Learning

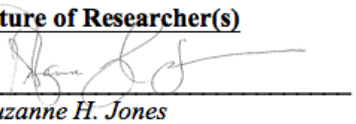
and will be kept for no longer than three years. Audio recordings will be destroyed following transcription and a pseudonym will be used in the subsequent written text.

IRB Approval Statement The Institutional Review Board for the protection of human participants at Utah State University has approved this research study. If you have any questions or concerns about your rights or a research-related injury and would like to contact someone other than the research team, you may contact the IRB Administrator at (435) 797-0567 or email irb@usu.edu to obtain information or to offer input.

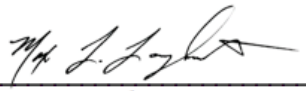
Copy of consent You have been given two copies of this Informed Consent. Please sign both copies and keep one copy for your files.

Investigator Statement "I certify that the research study has been explained to the individual, by me or my research staff, and that the individual understands the nature and purpose, the possible risks and benefits associated with taking part in this research study. Any questions that have been raised have been answered."

Signature of Researcher(s)



Dr. Suzanne H. Jones
Principal Investigator
(435) 797-1568
suzanne.jones@usu.edu



Max L. Longhurst
Student Researcher
(435) 797-7093
max.longhurst@usu.edu

Signature of Participant By signing below, I agree to participate.

Participant's signature

Date

Appendix C

Cyber-Enabled Learning Project Support Letter

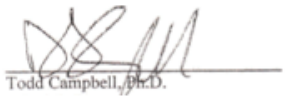
UCONN | Neag School of Education

June 30, 2014
Storrs, CT

Dear USU IRB committee,

As the Principal Investigator of the National Science Foundation, Cyber-enabled Learning: The Digital Native in Integrated Scientific Inquiry Classrooms grant I am supportive of allowing access to participating teachers to enable further investigation of professional learning. The *Adoption, adaptation, and abandonment: Appropriation of science education professional development* dissertation study proposed by Max Longhurst (Dissertation Chair—Suzanne Jones) has the potential to provide valuable insight to the process and application of instructional practice.

The multi-case qualitative investigation that seeks to explain factors that influence the appropriation of instructional tools associated with PD by using activity theory as a theoretical framework could positively influence how, when, where, and why we provide learning experiences for educators.



Sincerely,
Todd Campbell, PhD
Associate Professor-Science Education
Neag School of Education
University of Connecticut
Office 860-486-0515
todd.campbell@uconn.edu

Appendix D

Appropriation Classroom Observation Record

Appropriation Classroom Observation Record

School: ____ Date: _.

Teacher: ____Grade/Subject: _.

Anchor Act. #1	Anchor Activity Description:	Running Notes/Observations:	Time
Anchor Act. #2	Anchor Activity Description:		
Anchor Act. #3	Anchor Activity Description:		
Anchor Act. #4	Anchor Activity Description:		
Questions	Interview questions aligned to classroom anchors: 1. 2. 3. 4.		

New Ideas

Appendix E

Appropriation Participant Interview Record

Appropriation Participant Interview Record

School: _____Date: _.

Teacher: __Interview #: _Grade/Subject: .

Introductory Questions: 1. Discuss your teaching practice over the past 2-5 years? 2. Describe what you feel has influenced your instruction? 3. Please list the top factors that influence what you do with students in your science classroom. 4. How does your thinking about instruction interact with practical delivery of instruction?	Running Notes/Observations:
Anchor Activity #1 Question:	Running Notes/Observations:
Anchor Activity #2 Question:	
Anchor Activity #3 Question:	
Anchor Activity #4 Question:	
Emergent Question:	

New Concepts

Appendix F

Personal Appropriation Trajectory

Personal Appropriation Trajectory

School: ____Date: _.

Teacher: ____Grade/Subject:_.

	Practical Tool Disposition	**Integrated Disposition**	**Conceptual Tool Disposition**
Level 5 Appropriation Mastery			
Level 4 Appropriation of Conceptual Understanding			
Level 3 Appropriation of Surface Features			
Level 2 Appropriation of Label			
Level 1 Lack of Appropriation			

Check mark a cell above that exemplifies your perception of your ***disposition*** and ***level of appropriation*** at the timeframe described selected below.

□ Prior to iSit □ After 1st summer iSit □ After 1st winter iSit □ After teaching module 1 □ After teaching module 3
□ After 2 yrs of iSit □ After 2nd summer iSit □ After 2nd winter iSit □ After teaching module 2 □ After teaching module 4

Please provide a short example that exemplifies your selection.

CURRICULUM VITAE

MAX L. LONGHURST

Utah State University
School of Teacher Education and Leadership
2805 Old Main Hill
Logan, UT 84322-2805
Work: (435) 797-7093
Email: max.longhurst@usu.edu

655 South 700 East
River Heights, UT 84321
Mobile: (435) 881-3904
Email: max.longhurst@gmail.com

EDUCATION

Degrees

Ph.D.	2015	Utah State University, Logan, Utah Curriculum and Instruction Dissertation: *Adoption, adaptation, and abandonment: Appropriation of science education professional development learning.*
M.Ed.	1995	Arizona State University, Tempe, Arizona Elementary Education—Curriculum and Instruction
B.S.	1993	Brigham Young University, Provo, Utah Elementary Education

Certifications / Endorsements

A/SC	2010	Utah State University Administrative/Supervisory Certificate
NSDC Council)	2003	Learning Forward (National Staff Development Academy XIII Graduate

RESEARCH AGENDA

My research agenda focuses on conducting empirical research; using both quantitative and qualitative methodologies to better understand how professional learning influences teacher practice within the classroom. My current investigations target the appropriation of conceptual and practical tools from professional learning experiences. Specifically, this research is situated in the appropriation of professional learning for science teachers. Current investigations examine how teachers appropriately adopt, adapt, or abandon new ideas and techniques into the context of the classroom. I see value in understanding how current investments of time and money contribute to high quality improvements in the classroom experiences for learners. Connecting theory with practice is an essential aspect of my work.

PROFESSIONAL EXPERIENCE

School of Teacher Education and Leadership Outreach, Director **2009-Present**

Responsibilities include: Designing and providing professional learning across the state, developing and submitting grant proposals to fund professional learning, instructing coursework, supervision of administrative interns and practicum students, and serving on statewide science / STEM committees on behalf of the University.

Utah State University, Logan, Utah

Elementary CORE Academy, Director	2001-2008
University Instructor	
TEAL 6190—Theories of Teaching and Learning	Spring 2015
TEAL 6940—Administrative Supervisory Intern Supervisor	2013-Present
ELED 4000—Elementary Science Methods	2013-Present
ELED 3005—Beginning Classroom Management	2011-2013
ELED 4005—Intermediate Classroom Management	2011-2013
Student Teaching Supervisor (Utah State University)	2009-2011
ELED 6220—Workshop in Early Childhood Education	2003-2008
ELED 6240—Workshop in Science Education	2003-2008
ELED 6300—Workshop in Math Education	2003-2008
SCED 3300—Science Clinical I	Fall 2005
SCED 4300—Science Clinical II	Fall 2005
SubJournal, Managing Editor	2000-2002
Science for the NonScientist Workshops, Coordinator	1999-2001
SubOrientation Video and SubInstructor CD, Director	1999-2001

Elementary Teacher **(1997-1999)**
Cache County School District, Logan, Utah

Fifth Grade Teacher
- Biography Fair Coordinator
- Digital Portfolio Team
- Student Council Advisor
- Site Council, Member

Elementary Teacher **(1993-1997)**
Mesa Public Schools, Mesa, Arizona

Fourth, Fifth, & Sixth Grade Teacher
- Science Liaison
- Science Synergy Circle
- Technology Liaison
- Summer School, Head Teacher
- Principal's Advisory Council, Member
- Invention Convention, Chairperson

SCHOLARSHIP

Peer Reviewed Journal Articles

1. Campbell, T., Longhurst, M. L., Wang, S. K., Hsu, H. Y., & Coster, D. C. (2015). Technologies and reformed-based science instruction: The examination of a professional development model focused on supporting science teaching and learning with technologies. *Journal of Science Education and Technology*. DOI 10.1007/s10956-015-9548-6

2. Wang, S. K., Hsu, H. Y., Campbell, T., Coster, D. C., & **Longhurst, M. L.** (2014). An investigation of middle school science teachers and students use of technology inside and outside of classrooms: Considering whether digital natives are more technology savvy than their teachers. *Education Technology Research Development.* DOI 10.1007/s11423-014-9355-4

3. Campbell, T., Zuwallack, **Longhurst, M. L.**, Shelton, B. E., & Wolf, P. (2014). An Examination of the changes in science teaching orientations and technology-enhanced tools for student learning in the context of professional development. *International Journal of Science Education, 36*(11), 1815-1848.

4. Campbell, T., Dowdle, G., Shelton, B. E., Olsen, J., **Longhurst, M. L.**, & Beckett, H. (2013). Gaming as a platform for developing science practices. *Science Activities: Classroom Projects and Curriculum* Ideas, 50(3), 90-98.

5. Duffy, A. M., Wolf, P. G., Barrow, J., **Longhurst, M.**, & Campbell, T. (2013, April/May). Ecological investigations within an interactive plant community simulation. *Science Scope*. 36(8), 42-51.

6. Campbell, T., **Longhurst, M. L.**, Duffy, A. M, Wolf, P. G., & Shelton, B. E. (2013). Science teaching orientations and technology-enhanced tools for student learning in science. *Research in Science Education*. 43(50), 2035-2057. First published online 12 January 2013. DOI 10.1007/s11165-012-9342-x.

7. Campbell, T., **Longhurst, M**., Duffy, A., Wolf, P., & Nagy, R. (2012). Investigating human impact in the environment with faded scaffolded inquiry supported by technologies*. Science Activities, 49*(4), 99-107.

8. Zsiray, S.W., & **Longhurst, M. L.**, (2003). Electronic portfolio and resume project. *Theories and Practices in Supervision and Curriculum, 13*, 31-34.

9. **Longhurst, M. L.** (2001). Attracting and keeping GREAT substitute teachers *Impact: A Journal for Secondary School Principals,* 2(1), 15-17.

10. **Longhurst, M. L.** (2001). Handyman training for substitutes: How districts can prepare substitute teachers. *SubJournal: For Personnel Responsible for Substitute Teachers, 2*(1).

11. Hawkins, A., & **Longhurst, M. L.** (2000). Don't leave home without a SubPack. *New Teacher Advocate, 8*(1), 9.

12. **Longhurst, M. L.** (2000). Enhance "ONE" year of education. *SubJournal: For Personnel Responsible for Substitute Teaching, 1*(1), 40-47.

Books

1. Skinner, M., Lott, K., & **Longhurst, M. L.** (2010) *A Crack in the Night*. Logan, UT: Story-Express.
2. **Longhurst, M. L.** (2002). *Search for the Water Cycle.* Salt Lake City, UT: International Office for Water Education.
3. Smith, G. G., **Longhurst, M. L.**, Latham, G., Murdock, C., & Goldenhersh, B. (2002). *Substitute Teacher Handbook.* Logan, UT: Utah State University.

Peer Reviewed Conference Proceedings

1. **Longhurst, M. L.** (2014). Conceptual fidelity or contextual classroom adaptation: Appropriation from professional learning. In J. Settlage & A. Johnston (EDS.), *Proceedings of the Science Education at the Crossroads Conference* (pp. 54-55). Portland, OR. [Available online at www.scied]
2. **Longhurst, M. L.** (2012) *Developing educational and cultural awareness through value comparisons of international teaching assistants.* Paper presented at the 2012 International Seminar for Global Teacher Education and Teaching Practicum. December 18, 2012. Kyungpook National University, Daegu, South Korea. (Invited Presentation)
3. Freeman, M. K, Turner, S., **Longhurst M. L**., & Sol, Y. H. (2012). *An international teacher education experience at Utah State University.* Paper presented at the 2012 International Seminar for Global Teacher Education and Teaching Practicum. December 18, 2012. Kyungpook National University, Daegu, South Korea. (Invited Presentation)

Manuscripts Under Review

Longhurst, M. L., Jones, S. H., & Campbell, T. (2014). Influences on Teacher Implementation of Practices from Professional Learning. *Teacher Development* (Currently under review).

PROFESSIONAL PRESENTATIONS

Peer Reviewed Conference Presentations (International)

1. **Longhurst, M. L.**, Campbell, T., & Coster, D. (2015). *Impact of experiencing professional learning grounded in reformed science teaching practices and educative curricula: An investigation of the outcomes of a science teacher professional development.* Presentation at the 2015 Association for Science Teacher Education (ASTE) International Convention. Portland, Oregon.

2. Campbell. T., **Longhurst, M. L.**, Wang, S., Hsu, H., & Coster, D. (2014). *New technologies and reformed-based science instruction: An examination of the professional development focused on supporting science teaching and learning with technologies.* Presentation at the 2014 Association for Science Teacher Education (ASTE) International Convention. San Antonio, Texas.
3. **Longhurst, M. L.**, Campbell, T., Zuwallack, R., Duffy, A. M., Wolf, P. G., & Shelton, B. E. (2013). *Reexamining science teaching orientations and use of technology-enhanced tools for student learning: One year later.* Proceedings of the 2012 International Conference of the Association for Science Teacher Education (ASTE). Jan. 10-12. Charleston, South Carolina. http://theaste.org/pubs/proceedings/2013proceedings.pl
4. **Longhurst, M. L.**, & Joeckel, G. (2012) *PDF Syllabus Builder: Open-Source Tool for Online Instructors, Course Developers and Instructional Designers.* Presentation at 5th Annual Emerging Technologies for Online Learning International Symposium (Sloan-C). Las Vegas, Nevada.
5. **Longhurst, M. L.** (2012). *Developing Educational and Cultural Awareness Through Value Comparisons of International Teaching Assistants.* Presentation at 2012 International Seminar for Global Teacher Education Program and Teaching Practicum. Daegu, South Korea.
6. Campbell, T., **Longhurst, M. L.**, Duffy, A., Wolf, P., & Shelton, B. (2012). *Technology use in science classrooms and reformed teaching*. Presentation at 2012 International Conference of The Association for Science Teacher Education (ASTE). Clearwater Beach, Florida.
7. Lott, K., **Longhurst, M. L.** (2011) *Elementary CORE Academy: Possible impacts on elementary teachers and students.* Presentation at 2011 International Conference of The Association for Science Teacher Education (ASTE). Minneapolis, Minnesota.

Peer Reviewed Conference Presentations (National)

8. Wang, S. K., Campbell, T., Hsu, H. Y., Coster, D., & **Longhurst, M. L.** (2014). *Investigation of middle school science teachers' and students' use of technology inside and outside of classrooms*. Presentation at 2014 Annual American Educational Research Association (AERA) Meeting. Philadelphia, Pennsylvania.
9. **Longhurst, M. L.**, Jones, S. H., & Campbell, T. (2014). *Investigating the appropriation of professional learning through case studies.* Presentation at the American Association of Behavioral and Social Sciences (AABSS) 2014 National Conference. Las Vegas, Nevada.
10. **Longhurst, M. L.**, & Freeman, M. (2014). *Utilizing a particularistic method to investigate teaching practices of international teaching assistants.* Presentation at the Ethnographic and Qualitative Research Conference (EQRC) 2014 National Conference. Las Vegas, Nevada.

11. Shelton, B. E., Campbell, T., **Longhurst, M. L.**, & Olsen, J. (2014). *Great ideas in teaching and learning symposium, "Integrated scientific inquiry classrooms: Cyber-Enabled Learning and teacher professional development."* Boise State University, Boise, ID.

12. Shelton, B. E., Campbell, T., **Longhurst, M. L.**, & Olsen, J., *Great ideas in STEM education research, "Integrated scientific inquiry classrooms: Cyber-Enabled Learning and teacher professional development."* Boise State University, Boise, ID.

13. Freeman, M. K., Turner, S., & **Longhurst, M. L.** (2013). *A South Korean and U. S. teacher education partnership: A three-year report.* Presentation at the 2013 Northern Rocky Mountain Educational Research Association (NRMERA) Conference. Jackson Hole, Wyoming.

14. Child, B., Maahs-Fladung, C., & **Longhurst, M. L.** (2013). *Logan elementary math endorsement.* Presentation at the 2013 Math Science Partnership (MSP) Conference. Washington, D. C.

15. Campbell, T., Dowdle, G., Barrow, J., Stewart, A., Shelton, B.E., Duffy, A. M., **Longhurst, M. L.**, & Wolf, P. G. (2013). *Cyber-Enabled Learning in Unity: Scientific inquiry and gaming supported by assessment.* Presentation at the 2013 National Science Teachers Association (NSTA) National Convention. San Antonio, Texas.

16. Campbell, T., **Longhurst, M. L.**, Wang, S., Hsu, H.Y., & Runco, L. (2012). *Cyber-Enabled Learning: Beginning with a baseline*. (DR K-12 Grant # 1020086) Presentation at the Annual 2012 National Science Foundation Discovery Research K-12 Principal Investigator Meeting. Crystal City, Virginia.

17. **Longhurst, M. L.**, Nance P., & Paulson N. (2006) *Statewide professional development is possible: Utah's elementary CORE academy.* Presentation at the Annual National Staff Development Council (NSDC) Conference. Nashville, Tennessee.

18. **Longhurst, M. L.**, & Tippets, Z. (2002). *The electronic portfolio and resume project.* Presentation at the Nevada League of Professional Schools, Spring Conference Session Presentation. Henderson, Nevada.

19. **Longhurst, M. L.** (2002). *Training first year and substitute teacher.* Presentation at the National Association of Elementary School Principals (NAESP). San Antonio, Texas.

20. **Longhurst, M. L.** (2001). *Training first year and substitute teachers.* Presentation at the Annual National Staff Development Council (NSDC) Conference. Denver, Colorado.

21. **Longhurst, M. L.** (2001). *STEP-IN substitute teacher training.* Presentation at the Annual SubSolutions Conference. Park City, Utah.

22. **Longhurst, M. L.** (2000). *Enhance 1 year of learning with substitute teacher training*. Presentation at the Annual National Staff Development Council (NSDC) Conference. Atlanta, Georgia.
23. **Longhurst, M. L.** (2000). *Implementing district policies and practices that effectively recruit and retain substitutes.* Presentation at the Annual National Staff Development Council (NSDC) Conference. Atlanta, Georgia.
24. **Longhurst, M. L.** (2000). *Substitute training on a budget*. Presentation at the Annual SubSolutions Conference. Park City, Utah.
25. **Longhurst, M. L.** (1999). *Substitute teacher skill training*. Presentation at the Annual National Staff Development Council (NSDC) Conference. Dallas, Texas.
26. **Longhurst, M. L.** (1999*). Dealing with the substitute teacher shortage*. Presentation at the Annual American Association of School Personnel Administrators (AASPA) Conference Presentation. Phoenix, Arizona.

Peer Reviewed Conference Presentations (State/Local)

27. **Longhurst, M. L.** (2002). *When the cat is away the mice will…* Presentation at the Utah Mentor Teacher Academy Conference. Provo, Utah.
28. **Longhurst, M. L.** (2001). *Training substitutes and first year teachers.* Presentation at the Utah Association for Curriculum Development (UASCD/USDC). Park City, Utah.

Invited Presentations

1. **Longhurst, M. L.**, & Woods, S. (2015). *Presentation of Performance Task and Framework—New 6th Grade SEEd Standards.* Presentation at the Utah Science Teachers Association Annual Conference (USTA) 2015 State Conference. Provo, Utah.
2. **Longhurst, M. L.** (2014). *Using the practices.* Invited presentation to the Utah state office of education elementary principals mathematics and science leadership academy. Logan, Utah.
3. **Longhurst, M. L.** (2013). *Supporting professional learning through utilizing technology classrooms.* Invited presentation to the Utah state office of education elementary principals mathematics and science leadership academy. Logan, Utah.
4. **Longhurst, M. L.** (2011). *Mathematical Practice Standards.* Invited presentation at Cache County School District. North Logan, Utah.
5. **Longhurst, M. L.** (2008). *Multi-District Preschool Conference: Behavior, cognition and language acquisition.* Invited presentation at Granite School District. Salt Lake City, Utah.
6. **Longhurst, M. L.** (2005). *Using assessment in the classroom.* Invited presentation at River Heights Elementary. River Heights, Utah.

7. **Longhurst, M. L.** (2001). *5th & 6th Grade Science for the non-scientist workshop*. Elementary science teacher training. Bear Lake, Utah.
8. **Longhurst, M. L.** (2000). *3rd & 4th grade science for the nonscientist workshop*. Elementary science teacher training. Bear Lake, Utah.
9. **Longhurst, M. L.** (1999). *K-1 & 2nd grade science workshop*. Elementary science teacher training. Bear Lake & Provo, Utah.
10. **Longhurst, M. L.** (1997). *Student-led conferencing training*. School training for staff of Porter Elementary. Mesa, Arizona.
11. **Longhurst, M. L.** (1997). *Experiential education workshop.* School workshop for in-service teachers at Porter Elementary. Mesa, Arizona.

FUNDED PROJECTS (Total over $8 million)

1. Patterson, M., **Longhurst, M. L.**, Lott, K., Nadelson, L., & Tofel-Grehl, C. (2015). *Regional Partnership for Elementary STEM (ESTEM).* Elementary STEM Endorsement Cohort Program, Utah STEM Action Center. (2 year project), Total Support: $198,238.
2. Child, B., Moyer-Packenham, P., Kohler, B., Ng, D., & **Longhurst, M. L. (Co-P. I.)** (2012). *Elementary Math Endorsement Mathematics & Science Partnership Project*. Utah Mathematics and Science Partnership Grant, Utah State Office of Education. (3 year project), Total Support: $223,045.
3. Campbell, T., Wolf, P., Shelton, B., Coster, D., & **Longhurst, M. L. (SubAward P. I.)** (2010). Cyber-Enabled Learning: Digital Natives in Integrated Scientific Inquiry Classrooms. National Science Foundation Discovery Research K-12. Award#1020086 CFDA No. 47.076, Total Support: $2,500,000.
4. **Longhurst, M. L. (P.I.)** (2008). *Elementary CORE Academy*. State Professional Inservice Funds, C-7's. Utah State Office of Education. K, 1st, & 2nd Grades: $43,075; 3rd & 4th Grades $37,000; 5th, & 6th Grades; $35,000; Total Support: $115,075.
5. **Longhurst, M. L. (P.I.)**, (2008). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $145,000; 3rd & 4th Grades $98,000; 5th, & 6th Grades $100,000; Special Education $50,000. EA8331, EA8332, EA8333, AF14824, AF14827, AF14828, Total Support: $393,000.
6. **Longhurst, M. L. (P.I.)** Taylor, M., Kohler, B., & Smith, G. G., (2007-2009). *CORE Academy Mathematics and Science Partnership Project*. Utah Mathematics and Science Partnership Grant, Utah State Office of Education. (3 year project) AF # 14825, Total Support: $510,000.

7. **Longhurst, M. L. (P.I.)** (2007). *Elementary CORE Academy*. State Professional Inservice Funds, C-7's. Utah State Office of Education. K, 1st, & 2nd Grades: $40,000; 3rd & 4th Grades $37,000; 5th, & 6th Grades; $35,000; Total Support: $112,000.

8. **Longhurst, M. L. (P.I.)** (2007). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $253,373; 3rd & 4th Grades $93,000; 5th, & 6th Grades $154,000; Special Education $75,000. EA7346, EA7347, EA7345, AF14607, AF14608, AF14609, Total Support: $575,373.

9. **Longhurst, M. L. (P.I.)** (2006). *Elementary CORE Academy*, Professional Development Funding. WestEd. Total Support: $130,000.

10. **Longhurst, M. L. (P.I.)**, (2006). *Elementary CORE Academy*. State C-7 Discretionary Funding. Utah State Office of Education. K, 1st, & 2nd Grades: $40,000; 3rd & 4th Grades $32,000; 5th, & 6th Grades; $30,000; Total Support: $102,000.

11. **Longhurst, M. L. (P.I.)** (2006). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $85,000; 3rd & 4th Grades $93,000; 5th, & 6th Grades $95,000; Special Education $75,000; AF 14331, AF14319, Total Support: $348,000.

12. **Longhurst, M. L. (P.I.)** (2005). *Elementary CORE Academy*. State C-7 Discretionary Funding. Utah State Office of Education. K, 1st, & 2nd Grades: $65,000; 3rd & 4th Grades $30,000; 5th, & 6th Grades; $30,000; Total Support: $125,000.

13. **Longhurst, M. L. (P.I.)** (2005). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $112,495; 3rd & 4th Grades $95,000; 5th, & 6th Grades $95,000; Special Education $75,000; Total Support: $377,495.

14. **Longhurst, M. L. (P.I.)**, Evans, J. P., Rowley, E. R., & Smith, G. G. (2004). *CORE Academy Mathematics and Science Partnership*. Utah Mathematics and Science Partnership Grant, Utah State Office of Education. (3 year project) AF # 13874, Total Support: $639,015.

15. **Longhurst, M. L. (P.I.)** (2004). *Elementary CORE Academy*. State C-7 Discretionary Funding. Utah State Office of Education. K, 1st, & 2nd Grades: $40,000; 3rd & 4th Grades $40,000; 5th, & 6th Grades; $30,000; Total Support: $110,000.

16. **Longhurst, M. L. (P.I.)** (2004). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $185,000; 3rd & 4th Grades $192,495; 5th, & 6th Grades $50,000; Special Education $75,000; Total Support: $502,495.

17. Smith, G. G., **Longhurst, M. L. (P.I.)**, & Cangelosi, J. (2003). *CORE Implementation Model.* Utah State Agency for Higher Education. Total Support: $147,000.

18. **Longhurst, M. L. (P.I.)** (2003). *Elementary CORE Academy*, State Eisenhower Professional Development Program. Utah State Office of Education. K, 1st, & 2nd Grades: $60,000; 3rd & 4th Grades $57,549; 5th, & 6th Grades; $60,000; Total Support: $177,549.

19. **Longhurst, M. L. (P.I.)** (2003). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. K, 1st, & 2nd Grades: $210,000; 3rd & 4th Grades $190,000; 5th, & 6th Grades; $99,600; Total Support: $499,600.

20. **Longhurst, M. L. (P.I.)** (2003). *Elementary CORE Academy*, Special Education Support. Utah State Office of Education. Total Support: $40,000.

21. **Longhurst, M. L. (P.I.)**, & Smith, G. G. (2001). *Creation of "Search for the Water Cycle."* Utah State Office of Education. Total Support: $20,000.

22. **Longhurst, M. L. (P.I.)** (2002). *Elementary CORE Academy*, Professional Development Funding. WestEd. Total Support: $50,000.

23. **Longhurst, M. L. (P.I.)** (2002). *Elementary CORE Academy*, State Experimental Development Funds. Utah State Office of Education. Total Support: $35,000.

24. **Longhurst, M. L. (P.I.)** (2002). *Elementary CORE Academy*, State Eisenhower Professional Development Program Discretionary Funds. Utah State Office of Education. $126,016.

25. **Longhurst, M. L. (P.I.)** (2002). *Elementary CORE Academy*, State Staff Development Funds. Utah State Office of Education. Total Support: $100,000.

26. Zsiray, S. (P.I.), & **Longhurst, M. L.** (Co-P.I.) (2001). *Goals 2000 Electronic Portfolio and Resume Project.* Utah State Office of Education. Total Support: $30,000.

27. Smith, G. G., & **Longhurst, M. L. (Co-P.I.)** (2000). *Science for the Non-Scientist.* Eisenhower Professional Development Program, Utah State Office of Education. Total Support: $36,602.

28. Smith, G. G., **Longhurst, M. L. (Co-P.I.)**, Klag, P., Tolman, M., & Murdock, C., (1999). *Science for the Non-Scientist.* Eisenhower Professional Development Program, Utah State Office of Education. Total Support: $31,835.

TRAINING MATERIALS

Longhurst, M. L. (2008). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2007). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2006). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2005). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2004). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2003). Elementary CORE Academy Handbooks K-6.

Longhurst, M. L. (2002). Elementary Science CORE Academy Content.

Longhurst, M. L. (2002). *Search for the Water Cycle*, 4th Grade Water Curriculum.

Longhurst, M. L., Smith, G.G. (2000). *SubInstructor CD*. Logan, UT: Substitute Teaching Institute, Utah State University.

Longhurst, M. L., Smith, G.G. (1999). *SubOrientation Video*. Logan, UT: Substitute Teaching Institute, Utah State University.

PROFESSIONAL RECOGNITION

2014 **Outstanding Higher Education Teacher—**Utah Science Teachers Association, February 2014.

2009 **Marvin N. Tolman Life Long Service Award—**Utah Science Teachers Association, February 2009.

2004 **Outstanding Higher Education Teacher—**Utah Science Teachers Association, February 2004.

2001 **Telly Award**—Producer/Director of the SubInstructor CD, 2001.

2001 **Aegis Award of Excellence**—Interactive CD-ROM, SubInstructor Producer/Director, 2001.

2001 **Award of Distinction, The Videographer Awards**—SubOrientation, Substitute Teaching Institute, 2001.

SERVICE

Professional:

School Administrator Assessment Team Member Box Elder and Cache County School District screening	2014-2015
School of TEAL—Group Assessment Review Panel	2009-Present
Science Teacher Training for Cache County School District	2014
Guest Lecturer: University of Utah's GK-12 Program, Think Globally—Learn Locally	2014
School of Teacher Education and Leadership: Department Head Search Committee, Member	2014
School of Teacher Education and Leadership: Awards & Scholarship Committee	2013

Utah State Office of Education: Science Core Revision Team (6^{th} Grade Co-Chair of writing team)	2013-Present
Collaborator for the State MESA Challenge at Physics Day	2010-2014
Manuscript Reviewer—*Journal of Teacher Education*	2013-Present
Utah State Office of Education: Science Advisory Committee	2012-Present
Space Education Center, Board Member	2012-Present
MESA Competition Committee, Co-Chair	2009-2014
State Science Education Coordination Committee	2000-Present
Hillcrest Elementary Science Fair, Judge	2010 & 2011
Davis School District Science Fair, Judge	2010
PAEMST, State Coordinator	2007
Utah Scientifically Based Research Committee, Member	2005-2008
Managing Editor *SubJournal: For personnel responsible for substitute teaching.*	2000-2002
Science Synergy Circle workshop development	1995-1997

Community:

Eccles Ice Center Board of Trustees, President (Non-Profit)	2013-Present
Eccles Ice Center Board of Trustees, Member (Non-Profit)	2005-Present
Youth Soccer Coach	2004-Present
Cache Education Foundation Board, Member (Non-Profit)	2006-2012