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Community College Basic Skills Math Instructors" Experiences With Universal Design for Learning

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Walden University
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Abstract

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MA, University of California, Davis, 1994

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Dissertation Submitted in Partial Fulfillment

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Abstract

Multiple approaches have been used in U.S. community colleges to address the learning needs of postsecondary students who are underprepared in basic skills math. The purpose of this exploratory interview study was to gain a deeper understanding of community college basic skills math learning through instructors' lived experiences using the Universal Design for Learning (UDL) approach and its technology tool, a computerized pen. The conceptual framework for this study used Knowles's adult learning and Kolb's experiential learning theories with UDL principles. The central research questions investigated the professional development and teaching experiences of community college basic skills math instructors in their basic skills math curriculum in the California Community College system using a Smartpen. Interviews were conducted with 4 instructors, 2 of whom also participated in the 2011-2012 community college pilot project of the approach. The analysis consisted of coding and theme development in relation to the experiential learning process and the instructors' andragogy practices. This study identified 4 themes for use in understanding the instructors' experiences teaching with a Smartpen: *instructor preparation*, *technology use and savvy*, *student needs*, and *instructor flexibility/adaptability*. The study findings are of interest to community college basic math skills instructors, who can use these findings to inform their teaching preparation and teaching approaches, improving pedagogy and helping their students successfully complete their math courses.

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Dedication

This study is dedicated to my husband, Alonzo and our three children, Amanda, Beniah, and Caden, who provided me with countless hours of minimal distractions so I could study and write. Thank you for being there for me and supporting me with love and quiet whispers, which helped me get through this journey.

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Chapter 1: Introduction to the Study

California Community College (CCC) students are required to complete a precollege level math course at the level of Intermediate Algebra or higher as one of the requirements to receive an associate's degree, some career and technical certificates, and/or to transfer to a 4-year college (Academic Senate for California Community Colleges [ASCCC], 2013). CCCs educate almost 2.4 million students each year; approximately 85% of first-time CCC students are assessed as needing at least one pretransfer level course (ASCCC, 2013; California Community College Chancellor's Office [CCCCO], 2012). The multiple basic skills math classes required for these underprepared postsecondary students can affect their progress towards their academic degree completion and career goals. A little more than half of these underprepared students successfully complete their basic math skills courses (ASCCC, 2012; Illowsky, 2008). This poor progress has social implications including students' delayed entry into the workforce and businesses being unable to fill higher skilled jobs. This study was designed to explore a potential solution to this problem by examining instructors' teaching approaches and improve the understanding of how to increase the students' completion rates in basic skills courses.

Universal Design for Learning (UDL) is a framework for teaching and learning often used in the elementary and secondary education systems (Roberts, Park, Brown, & Cook, 2006; Rose, Harbour, Johnston, Daley, & Abarbanell, 2006; Rose & Meyer, 2002; Schelly, Davies, & Spooner, 2011). UDL focuses on curriculum design and instruction as well as student engagement with the material (e.g., students' motivation and interest) and

student expression (i.e., how they express their knowledge, such as writing an essay, making a video, or giving an oral presentation). At the time of this study, the UDL framework had not been extensively used as an approach to learning basic skills math for students at the community college level. One of the limited examples was a pilot project in 19 CCCs explored UDL's potential use in meeting the needs of basic skills math students of diverse age groups at the community college level (Smartxt Universal Learning Program [SULP], 2012). The goal of this pilot project was to apply UDL and one of its technology tools, a Smartpen as a method to bring more students up to college level math more successfully and quickly (SULP, 2012).

In this research study, I explored this UDL approach to teaching basic skills math from instructors' perspectives. I used the literature review for this study to develop a foundation for understanding and exploring this approach to teaching basic skills and basic skills math, particularly with community college students who come from diverse age groups. I specifically used Knowles' adult learning theory and Kolb's experiential learning theory to help inform the discussion and understanding of this approach and to provide a basis for analyzing the instructors' experiences.

This chapter begins with a background of the problem being addressed that includes a description of the 2011-2012 pilot project that trained instructors in the UDL approach explored in my study. In the background section, I discuss the scope of the study, gap in knowledge, and need for the study. Next, the study's problem statement follows, indicating this study's relevance to the discipline and how this research builds on prior and current research in adult learning in higher education and UDL while

addressing a gap in the literature. In the purpose of the study section, I state the research paradigm of narrative and the study's intent. The next section of the chapter includes the research questions and conceptual framework used to ground the study: andragogy (Knowles, 1973), experiential learning (Kolb, 1984), and UDL (CAST, 2014).

In subsequent sections of the chapter, I cover definitions of terms and assumptions that could have an effect on my study. The scope and delimitations follows with the boundaries of my study and potential transferability of study results. The limitations section includes methodology weaknesses and any biases that could influence my study and thus need to be addressed. In the final section prior to the summary, I cover my study's significance, indicating any potential contributions related to policy and practice as well as any potential implications for positive social change.

Background

Community colleges across the United States serve about half of all first time college freshmen within their doors, including many adult learners (Beach, 2011). Over 2.4 million students were served by the CCC system each year, making it the largest community college system in the world (CCCCO, 2012). In 2014, 7 million students in the United States were enrolled full- or part-time (American Association of Community Colleges, 2014). Historically, CCCs have been institutions of open access for students of varying educational backgrounds, skill level, ethnicities, socioeconomic status, age, and learning styles: Any student 18 years old or older may enroll and attend a CCC without a high school diploma, which is often termed as open access (CCCCO, 2012).

The nature of CCCs being open access means that these diverse groups of students are provided with opportunities for gaining a postsecondary education that might not have been available to them in other higher education institutions. With this open access, students of varying backgrounds, skill levels, and ages can become educated and trained in various majors or career programs.

Assessments and Basic Skills

Many students arrive at U.S. community colleges with low skill levels in math, reading, and writing. Nationwide, 44% of all first-time community college students enroll in at least one developmental course (Eddy, 2013, p. 5). In California, of the 350,129 mathematic assessments completed in the fall 2010 semester, only 14.6% of the students assessed into transfer-level math, with the remainder assessing in one to six levels below transfer-level math (CCCCO, 2012). Approximately 65% of the CCC fall 2010 cohort assessed two levels or more below transfer level, which is elementary or beginning algebra mathematic courses and only 14% of these students succeeded in completing transfer level math courses (CCCCO, 2012, p. 5). These numbers indicated a significant problem for CCC students who need to be placed into and complete basic skills math courses before they can continue with their long-term educational goal of completing a degree. Almost three-fourths of students who begin in basic math ultimately do not complete this college-level math course successfully (Bahr, 2013, p. 172). Most of these students subsequently leave the community college without completing a degree or transfer requirements (Bahr, 2013), which is an undesirable outcome.

Students in CCCs take a placement exam as part of the advising and registration process when enrolling in college courses (ASCCC, 2014). These placement exams are designed to assess appropriate skill placement for English, reading, and math courses. The type of placement exams vary depending on the college district; however, all CCCs use one of the State Chancellor's Office approved standardized assessments as part of the process to place students in their writing, reading, or mathematic courses (ASCCC, 2014). However, no single measure is used to place a student within a particular course, as this can cause misplacement of students in courses either too low or too high for their skill set (ASCCC, 2014). The standardized measures used as a part of the placement process in English, reading, and math courses as an advising process and term are called *multiple measures* (ASCCC, 2014, p. 3). These multiple measures are used to place students in appropriate level English, reading, and math courses. Other factors in placement may include student's high school transcripts, other college transcripts, student's self-reported confidence level, advanced placement scores, and more (ASCCC, 2014). This placement process often happens during individual advising or orientation sessions (ASCCC, 2014; CCCCO, 2012).

Many students must master several basic skills classes in math, reading, and writing in order to complete the college level coursework needed to earn an associate's degree, a career or technical certificate, and/or transfer to a 4-year institution, (Bahr, 2013; CCCCO, 2012). Many associate's degree and transfer requirements have prerequisites of beginning or intermediate algebra courses. As a result students who need to achieve associates or transfer level math such as statistics, college algebra, precalculus

or higher, must first complete some levels of beginning and intermediate algebra as prerequisites. For those who have basic skills challenges related to learning disabilities or long-term lack of exposure to algebra, starting in basic math courses such as prealgebra may be necessary. For some students this means they may need to progress through three to four nondegree applicable basic skills math courses before meeting the requirement to complete the actual math course they need for an associate's degree, career or technical certificate and/or to transfer to a 4-year program.

The result of these factors is that a basic skills math course can become a significant barrier for students in completing their educational goals (Bahr, 2013; George, 2010; Illowsky, 2008; LaManque, 2009; Stern, 2012). In California, the statewide, the basic skills math course completion rate has shown slow increases, with a 51% course completion rate in 2008–2009, to a 53% completion rate in 2010–2011 (CCCCO, 2012). This data suggests that California's effort to help the nation meet a challenge to produce more college graduates by the year 2025 is slowly improving (Bogg, 2011). However, the State of California needs to improve its college success and completion rates to strengthen these efforts to meet the goal.

UDL Approach to Teaching Basic Skills

A relatively recent approach to teaching basic skills at the college level is implementing UDL strategies and techniques in a basic skills math course. This practice was tested in a pilot project conducted in 19 CCCs in the academic year 2011–2012. UDL is "a set of principles for curriculum development that gives all individuals equal opportunities to learn" (Center for Applied Special Technology [CAST], 2014). The

UDL concept originated in the 1980s when the architect Mace coined the phrase *universal design* in reference to products and physical environments (Center for Universal Design, 1998). UDL provides a framework to create curriculum with instructional goals, methods, materials, and assessments that can work for everyone, not as a single solution that cannot be flexible for individual needs (CAST, 2014).

The UDL process involves looking at and developing products and environments with the widest range of diverse users in mind, such as curb cuts in sidewalks and automatic door openers. Examples given by Rose and Meyer (2002) included curb cuts that were designed and intended primarily for people in wheelchairs also assist people pushing strollers, riding scooters, and carrying heavy or large objects. These curb cuts make it easier for all users to move from the sidewalk to the road and back to the sidewalk. Similarly, the automatic door openers on building entrances, originally designed to work for people in wheelchairs or with limited strength, as well as people carrying objects in both hands, make access to buildings better for anyone (Center for Universal Design, 1998).

The basic skills math curriculum with UDL was designed with three principles and is taught with a diverse range of learners in mind (Rose & Meyer, 2002). The first principle recognizes the need for multiple means of representation or knowledge delivery that most students need more than one modality in presentation of knowledge. The second principle, multiple means of engagement, recognizes that students need to be engaged with the information and allow for motivating the student to learn the material. Finally, the third principle of multiple avenues of expression means that students need to

be given opportunities to express their learned knowledge in different ways. This UDL approach was adapted to the 2011 pilot project at 19 CCCs with a general student population in higher education, instead of the original purpose in working with learning disabled populations (SULP, 2012). The purpose of the basic skills math pilot project was to see if UDL could be used as a way to benefit students' learning through instructional support. However, success was not measured in the final report.

This dissertation study addressed the experiences of instructors' use of UDL in a general community college population in their teaching and whether it addressed the problems they encounter teaching basic skills math. The technology used in the 2011-2012 pilot project included audio recordings of the lectures synchronized to video captions of the student's handwritten notes. The audio and written notes were uploaded to a shared Internet-based drive to which all the students in the class had access. The audio and written notes that were uploaded were called *pencasts* (SULP, 2012, p. 1).

At the time of my research study, there was little research in implementing UDL widely in higher education (Rose & Dalton, 2009; Rose et al., 2006; Rose & Meyer, 2002). Not addressed by the 2011-2012 pilot project itself were the experiences of the community college instructors teaching basic skills math with UDL. The intent, then, of my research study was to examine the narrative experiences of basic skills math instructors who have continued to teach at the community college level with the UDL. The specific focus in my study was on the UDL-technology tool, a computerized pen, commonly referred to as a Smartpen (SULP, 2012). Understanding the nature of the instructors' experiences with this UDL approach was designed to provide insight into

factors that may have assisted their teaching students in basic skills math classes, as well as what factors influenced the students learning basic skills math. The knowledge gained was intended to inform curriculum development approaches to adults in higher education, not just in math basic skills classes or with the learning disabled. In addition, understanding of the instructors' own developmental process and experience in using UDL and a Smartpen to teach community college students could assist other community college faculty in developing curriculum for students with diverse backgrounds, skill levels, and ages.

UDL is an approach to teaching and learning that could help students become more successful in basic skills math classes. This dissertation study was needed to gain a better understanding of the UDL approach at the community college level, since UDL is not yet widely used in higher education (Rose & Meyer, 2002; CAST, 2014). In order to develop a better understanding, the study was designed to examine instructors' experiences teaching basic skills math with this UDL technology tool. These experiences might serve as a template for other instructors incorporating UDL approaches into their instruction.

This focus on UDL in higher education, specifically at the community college level, extended the field knowledge regarding teaching adult learners and understanding student learning of basic skills math. Future applications for this study could include replicating and implementing the UDL approach in any of the 112 CCCs' basic skills math courses, or community colleges across the country. Other researchers and practitioners could also use this study information to try this UDL approach with other

basic skills courses in English and reading, or college-level courses such as psychology and anatomy.

Problem Statement

Although UDL has been effectively applied to the K-12 population when students with learning disabilities are involved (Rose et al., 2006), it was not clear prior to this study if a UDL approach worked from an instructor perspective in community college environments. The specific problem investigated by my study was that it was not clear if a UDL approach worked from the perspective of instructors' experiences when applied to a diverse community college population in a basic skills math curriculum. This lack of clarity is important because basic skills math classes in community colleges tend to be a form of gatekeeping to degree completion for students (Illowsky, 2008).

At the time of my study, UDL did not have an established presence in higher education or for students without learning disabilities (Rose et al., 2006). The 2011-2012 pilot project implemented a UDL approach with the technology tool referred to as a Smartpen in basic skills math classes (SULP, 2012). This specific tool incorporates two of the three UDL principles: multiple means of representation and multiple means of engagement. At the time of my study, there were also limited studies about UDL and its learning approaches in the community college student population with outcomes in basic skills math (LaRocco & Wilken, 2013; Messinger-Willman & Marino, 2010; Roberts, Park, Brown, & Cook, 2011; Rose & Meyer, 2002). My study was therefore designed to examine the experiences of instructors using a UDL approach and its technology tool in their teaching. The study was also designed to help determine whether use of UDL with

the diverse population of community college students suggests a different approach to providing a more effective teaching approach to students in basic skills math with diverse backgrounds, skills, and ages. The results for this study based on the experiences of the instructors indicated that the use of a UDL approach served as one method to help adult learners learn basic skills math.

Purpose of the Study

This exploratory interview study with phenomenological and narrative aspects focused on the experiences of community college instructors who use UDL and a Smartpen to teach basic skills math classes. This study was also designed to explore the sequence of events related to their experiences in learning to use and apply UDL and this technology tool to gain a deeper understanding of the teaching options using a UDL approach with this new population of students.

Research Questions

The research questions investigated by this study were:

1. What are the professional development and teaching experiences of community college basic skills math instructors who use UDL and Smartpens in their basic skills math curriculums?
2. In what ways has the experience of using UDL and Smartpens informed community college basic skills math instructors' current teaching approach?

Conceptual Framework

The conceptual framework for this study incorporated two theories and one inquiry focus: Knowles's (1973) adult learning theory, Kolb's (1984) experiential

learning theory, and UDL principles (CAST, 2014). These elements collectively formed the lens used to examine and develop the interview questions and added a meaningful perspective in this phenomenological narrative study. Knowles's (1973) andragogy or adult learning theory includes several core adult learning principles that helped frame the interview questions: (a) need to know, (b) learner self-concept, (c) learner's experience, (d) readiness to learn, (e) orientation to learning, and (f) motivation to learn (p. 141). These principles helped build the meaning and essence of the participants' experiences in the pilot project. Understanding the core adult learning principles and which principles seem prevalent in this research study can provide higher education administrators and curriculum developers with themes that could suggest a path for successful basic skills math completion.

Kolb's experiential learning theory (1984) examined how people learn using learning styles that fall along two intersecting continuums. On opposite ends of one of Kolb's continuum were learning by doing (active experimentation) and learning by watching others (reflective observation). The opposite ends of the intersecting continuum were learning by feeling (concrete experimentation) and learning by thinking (abstract conceptualization; Kolb, 1984). Kolb held that people learned continuously and that this learning process was grounded in their experiences. The instructors described their experiences in basic skills math using UDL and Smartpen. Their personal processes were expected to connect to Kolb's learning styles. Learning style patterns immerged and can be helpful for community college curriculum designers to increase successful basic skills math completion.

The UDL principles are part of the conceptual framework related specifically to the research questions. UDL is the instructional and learning framework that focuses on multiple means of representation (conveying knowledge), multiple means of engagement, and multiple means of expression (demonstrating knowledge learned; Rose & Meyer, 2002). UDL has been implemented in elementary and secondary settings as well as special education (CAST, 2007; Rose & Meyer, 2002). Understanding UDL use at the higher education level with a general population addresses a gap in the field. Combined with the theories of adult learning theory and experiential learning, the UDL lens was used for understanding the instructors' experiences utilizing a UDL technology tool in basic skills math teaching (SULP, 2012). This conceptual framework will be discussed further in Chapter 2.

Nature of the Study

In this exploratory interview inquiry, I used aspects of phenomenology and narrative sources to explore the essence or meaning of the experiences that instructors lived through in either participating in the UDL basic skills math pilot project or continuing to teach using UDL and a Smartpen. A phenomenological approach is taken when a researcher intends to study the lived experiences of people who shared a phenomenon and reduce those experiences to a description of a universal essence (Moustakas, 1994). As this particular phenomenon was the result of a 2011-2012 pilot project three years earlier, a narrative aspect of the study will be included with the phenomenological approach in analysis. The narrative inquiry tells the story in respect to

the time, place, and social interactions. It is the collaboration between the participant and researcher (Clandimin & Huber, 2010).

The central phenomena chosen for this study were the experiences of the community college instructors teaching basic skills math, using UDL approaches specifically the Smartpen as one of the technology tools. In the academic year 2011-2012, the pilot project manager from one branch of the community college recruited math instructors from a total of 19 community colleges to participate and use UDL and a Smartpen in their basic skills math classes. While the pilot project was not officially continued, at least the project manager's campus and several others continued to use this approach in basic skills math. The focus of this study, therefore, was on the experiences of basic skills math instructors who have continued to use UDL and a Smartpen in their teaching.

This study used interviews with a convenience sample of four instructors who used the UDL and Smartpen in their teaching math at the pilot project's host community college. The intent of the interviews was to explore both the story and the essence, or meaning, of the phenomenon of teaching basic math to community college students using UDL and one of its technology tools. The narrative inquiry focused on understanding the experience in the dimensions of time, place, and social interaction, similar to a story (Clandinim & Huber, 2010).

Data collection consisted of two hour-long recorded and transcribed individual interviews with each of the four instructors using a protocol I developed, followed by member checking of the transcriptions. The pilot project's end of the year report was

used to develop some of the questions asked in the interviews (SULP, 2012). The data collected was analyzed in a manner suggested by Moustakas (1994). One method of phenomenological data analysis included (a) verbatim transcription of the described experiences, (b) recording all significant statements, (c) reducing repetitive, overlapping statements, (d) relating and clustering meaning units into themes, and (e) synthesizing meaning units and themes into a textual-structural description of the experience, including verbatim statements (Moustakas, 1994, p. 122). For data triangulation, I used member checking with participants to ensure the data, analysis, interpretation, and conclusions are accurate and credible.

Definitions

Basic skills math: In the context of this study, community college math classes that are one or more levels below college level intermediate algebra, such as beginning algebra, elementary algebra, pre-algebra, and arithmetic. These classes are often prerequisites to college credit math courses (Illowsky, 2008).

Pencasts: Digital recordings of audio lectures synchronized to written, visually recorded notes (SULP, 2012).

Smartpen: A specialized computer pen that records what is being written on special computer paper and syncs the audio recording to the written notes (called *Pencasts*). This pen is sold commercially and was supplied free of charge to the colleges that participated in the pilot project (SULP, 2012).

Universal Design for Learning (UDL): An approach to curriculum design, teaching, student engagement, and learning that uses three guiding principles: multiple

means of representation, multiple means of engagement, and multiple means of expression (Rose et al., 2002). It is part of the conceptual framework for this study.

Assumptions

There were several assumptions regarding this study. One assumption was that there were a number of instructors who continued to teach basic skills math with the UDL technology tool after the pilot project was completed. Another assumption was that those instructors who were willing to be interviewed had clarity in recall of their experiences from three years previously to current use. Since the focus of this study was to examine the UDL approach used for basic skills math these assumptions are believed to be true and are necessary to hold in the context of this study.

Scope and Delimitations

The scope of this study was focused on the experiences of the instructors who teach basic skills math using the UDL and a Smartpen. A total of four instructors were used. Two of the instructors were involved in the Spring 2012 basic skills math pilot project using the UDL technology tool. The other two instructors began using UDL and the tool when teaching for the host college about a year after the pilot. Of the four instructors, three are actively using the pen in their teaching. The fourth participant, who was not one of the original users, is no longer using the pen, due to the difficulties during his semester of use. The study is delimited to those instructors who have used UDL and a Smartpen in their teaching.

The study's population included the community college instructors teaching a basic skills math course using a Smartpen. The population included both men and

women instructors of varying ages. However neither age nor gender will be considered for selection in the sample from the population. Only the instructors' willingness to participate was considered, therefore providing the scope and delimitation.

Limitations

In the case of an exploratory interview study, the smaller number of participants limits the transferability of the data, yet it helped deepen the understanding of instructor experiences with the UDL approach and math when participating in a shared experience since the interviews provided substantial data about the experiences. The original pilot project occurred in spring 2012 and the instructors who participated in the study may now have differing views on their experiences due to time lapsed and recall. My college was one of the participating colleges in the pilot project and one instructor who participated in the project is now teaching for another college. However, I was not involved with the pilot project on my campus and did not work with the faculty teaching in it at my college. Therefore, there would be no bias or conflict of interest should any faculty who were previously at my college become one of the possible instructors interviewed. Although I use a Smartpen in my personal and professional life this will only enhance my ability to understand the context of some of the experiences that may be described by those interviewed. My use of the Smartpen had minimal bias and minimal impact on the inquiry, interpretation and approach to my study.

Another limitation was the study did not provide representative data with analysis for generalizing or transferability of data to larger populations. It provided an in-depth examination of the instructors' approaches to teaching basic skills math to community

college students, which led to identifying certain elements or the essence of their experiences. These elements provided support to other basic skills math instructors who wish to apply these insights to their own teaching to community college students.

Significance

The California Community College (CCC) system is the largest in the world and serves over 2.4 million students each year (CCCCO, 2012). Successful CCC programs can have a wide-reaching effect on other community colleges within the nation. Basic skills math instruction is necessary as intermediate algebra or higher-level math is required to receive a community college associate's degree in the state of California. When more than one in every three first time CCC students enroll in a basic skills course, over half of which are basic skills math classes (CCCCO, 2012), the CCC system cannot afford to have basic skills math courses serve as a bottleneck or gatekeeper to successful completion of an associate degree. It could also provide another approach to retaining basic skills math students to their goal completion. UDL is a framework of teaching and learning principles with good measure of success in the K-12 and special education areas, yet has limited exposure in higher education (Rose et al., 2002). I developed the interview questions for this study with the intent to link the UDL principles to the instructors' teaching perspective in basic skills math. The potential contributions through the development of deeper understanding on teaching with a UDL approach can assist other instructors in implementing UDL and a Smartpen in their basic skills teaching.

Appropriate use of UDL has the potential to be a source of positive social change through application of its principles and intent. Its purpose is to reach the widest range of

diverse users by meeting them where they are, rather than forcing conformity in learning. UDL changes the way that traditional education has functioned (CAST, 2014). UDL allows users to learn in the way that works for them and can help them achieve the goal of education. It changes traditional education to education designed to meet the needs of its users rather than trying to change the user to fit the curriculum (Rose & Meyer, 2002). It may give community college students who may not have been able to meet basic math requirements a chance to achieve their educational goals. Since the basic skills math pilot project has continued and more students and instructors are engaged in similar experiences, what is gathered and learned in this study could be of use in other community college basic skills math courses, as well as other courses to enhance student success.

Summary

In order for CCC students to complete an associate degree, career or training certificate, or transfer to a 4-year college, successful completion of math courses is required. Many students struggle and have difficulty completing the necessary prerequisite basic skills math courses to achieve these levels. Exploring one approach to teaching basic skills math with UDL principles and its technology tool could be valuable research for the field of education. This study was designed to gain a deeper understanding of the lived, shared experiences of community college instructors who use UDL and a Smartpen in teaching basic skills math courses. This study used the conceptual frameworks of adult learning, experiential learning, and UDL to help aid in that understanding.

Chapter 2 follows with a review of current and relevant literature. In Chapter 3 I provide the research design and rationale, as well as methodology used. In Chapter 4 I discuss the results related the research questions. Chapter 5 concludes the study with interpretation of results, any limitations of the study, as well as recommendations and implications for future studies.

Chapter 2: Literature Review

Math courses function in part as a form of gatekeeping for U.S. community college students with basic skills challenges in math level (Bahr, 2013; Illowsky, 2008;). One approach to teaching basic skills math at a community college was to incorporate a UDL technology tool into the instruction. UDL is a conceptual framework for teaching and learning that has been predominately applied in the U.S. K-12 school system, and has been effectively used in special education (Rose et al., 2006). Smith (2012) suggested that UDL could also be used by college instructors to expand and deliver course instruction that meets the needs of diverse learners.

An essential part of UDL is having clear goals that align to meaningful and attainable objectives (Rose & Meyer, 2002). UDL can help college instructors develop rich, varied, effective, and meaningful learning opportunities for students with and without learning disabilities (Smith, 2012). Although the research in the field is improving, the research on UDL remains limited (Smith, 2012). This dissertation study was designed to address this gap by exploring the experiences of instructors with the use of UDL in community college basic skills math classes. The specific purpose of this dissertation research was to conduct an exploration related to community college instructors' experiences teaching basic skills math using UDL and its technology tool to gain a deeper understanding of teaching approaches for basic skills math.

CCC is the largest higher education system in the United States and serves over 2.4 million students each year (Bahr, 2013; CCCCO, 2014). Yet, about 80% percent of those students who are first time students score into the basic skills levels for English,

reading, and math skills and have a low percentage of successful completion of these basic skills courses (Bahr, 2013; CCCCO, 2014). Only about 50% of CCC basic skills math students in the 2009-2010 academic year successfully completed their basic skills math courses (CCCCO, 2012). This percentage cannot meet the workforce needs of the State of California and the Lumina Foundation's Achieving the Dream national challenge of increasing degree completions by 2025 (Bogg, 2011).

A basic skills math pilot project was conducted in 19 separate CCC during the 2011-2012 academic year. That pilot project integrated assistive, multi-sensory technologies as a resource for basic skills math instructors and students. That math pilot project used UDL principles through the teaching and curriculum design of the coursework and a technology tool referred to as a Smartpen. The project was developed as a way to serve students with learning disabilities in mainstream community college math classes as well as all students including unidentified students with learning disabilities (SULP, 2012, p. 1). The pilot project was implemented as a part of meeting the accommodations of students with disabilities without putting additional stress on budgets and services within the college (SULP, 2012). No research or review of research had been done to establish a foundation for that 2011-2012 pilot project. This dissertation study was designed in part to as a follow-up to that basic skills math 2011-2012 pilot project to add to the field of research regarding the instructors' experiences and perceptions of the effectiveness of this approach to teaching basic skills math.

Synopsis of the Literature

The literature review that follows covers UDL curriculum, course design, and technology use; student and faculty perceptions of UDL, and the current approaches to postsecondary math. There are UDL approaches using assistive and adaptive technology in ways to provide teaching and learning flexibility (Dolan, Hall, Banerjee, Chun, & Strangman, 2005; Messinger-Willman & Marino, 2010; Morra & Reynolds, 2010; Parker & Banerjee, 2007; Rose & Dalton, 2009; Schelly, Davies, & Spooner, 2011; Wissick & Gardner, 2008). Some of the key studies examined include research that showed the implementation of UDL strategies and models (Gradel & Edson, 2009), course/curriculum and assessment design in UDL (Harrison, 2006; Ofiesh, Rojas, & Ward, 2006), and UDL implementation at the postsecondary level (Rose et al., 2006).

Additionally, in the literature review I explore how basic skills intersects with postsecondary education, particularly in aspects of learning math, the learning experiences of adult learners, and UDL (Chaves, 2006; Galbraith & Jones, 2008; George, 2010; Illowsky, 2008; Mesa, 2012; Woodson-Day, Lovato, Tull, & Ross-Gordon, 2011). This review identified limited research that focused on the community college level and examined outcomes related to basic math and UDL technology tools (Hehir, 2009; LaRocco & Wilken, 2013; Messinger-Willman & Marino, 2010; Roberts, Park, Brown, & Cook, 2011; Rose & Meyer, 2002). Much of the research in the field highlighted aspects of UDL, basic skills, technology, and learning, but there is a limited body of literature about UDL at the community college level.

Preview of the Chapter

In this chapter, I first reiterate the problem and purpose of the research study. Next, I cover the literature search strategy used to do an exhaustive search of the research within this field to identify a gap. The conceptual framework section includes a discussion of Knowles's (1973) adult learning theory, Kolb's (1984) experiential learning theories, and the rationale for their application to this research. A discussion of UDL principles (CAST, 2014) and the basics skills inquiry round out the conceptual framework for the phenomenon being studied. Finally, the last section addresses the literature review and research related to UDL curriculum, course design and technology use, the perspectives of faculty and students in using UDL, and teaching approaches for basic skills math at the postsecondary level—all key variables and concepts within the phenomenon researched. The conclusion of the chapter contains a summary regarding what is known and not known in the field related to UDL and basic math skills development at the postsecondary level, including the specific research gaps that were identified and which came the basis for this research study.

Literature Search Strategy

The literature review was based on an extensive search of the Education electronic databases: SAGE, ProQuest and EbscoHost. The following search categories were paired together in various combinations to find studies relevant to this dissertation study: *community college*, *student motivation*, *perceptions*, *basic skills math*, *basic skills*, *higher education*, *postsecondary*, *adult learners*, *experiential learning*, *assistive technology*, *technology* and *universal design for learning. Developmental math* and

remedial math were also used in the search categories, although the search results did not always address the population or essence of the definition used for basic skills adult learners.

I searched using three sets of date parameters: 2008–2014, 2000–2014, and none. These publication date parameters were intended to assist with finding the most current literature. When some of the searches yielded over 100 articles, not all of them were relevant to the topic; therefore, I used progressively wider year ranges to identify relevant literature. I used older articles because of the relevance of their findings, although their study populations were composed of secondary students rather than higher education students, or of special education students rather than nonspecial education students. Additionally, some of the older articles used had a focus on UDL and higher education, but were outside of the recent five year range to be most current. These articles still provided a basis for the foundation of this study and demonstrated that there was a limited body of current research with community college students and UDL.

I also identified some articles related to experiential learning theory through the use of Google Scholar. I used searches for verbatim article titles from references cited in Kolb, Boyatzis, and Mainemelis (1999) to identify two additional articles that were available for use. These articles, although older, were helpful in developing the background for understanding the experiential learning theory within this study.

Conceptual Framework

The conceptual framework for this research study used three lenses: Knowles's (1973) adult learning theory, Kolb's (1984) experiential learning theory and UDL

(CAST, 2014). Community college students make up a diverse demographic that has historically been and mostly still is comprised of older students who are 25+ years of age, female, working class, and from ethnic/racial minority backgrounds (Beach, 2011; Dougherty, 2001). Many of these students come to the community college from life experiences outside of high school. Knowles's (1973) adult learning theory was used because understanding the important elements of an adult learner and how these characteristics differ from a traditional aged student (18-24 years of age) can impact the methods used to teach these adult learners.

Knowles's Adult Learning Theory

Andragogy is the art and science of adult learning (Knowles, 1973). It focuses on adult learners and their learning process, and is comparable to pedagogy (the art and science of teaching mainly focused on young children; Knowles, 1973). Knowles's ideas were formed around the concept of informal adult education in 1950 and by Knowles's exposure to the term *andragogy* in the mid-1960s by Yugoslavian colleagues, which helped in providing a more adequate organizing concept (p. 40). Knowles's theory focuses on adult learners as individual learners and how they process the learning; it also illustrates the processes of learning as the center of the education process, rather than teaching (p. 40). By contrast, pedagogy relies on the teacher to take full responsibility for making all educational decisions such as what will be learned, how it will be learned, and when it will be learned (Knowles, Horton, & Swanson, 2005, p. 61). Students within the Knowles's pedagogical framework are being teacher-directed and subject-centered in their educational process. Learning emphasizes the changes that occur or are expected to

occur in the person (Knowles et al., 2005). Learning from a problem-based and contextual focus with use of prior experiences should have an intrinsic value for adult learning to occur more easily. These aspects are part of the core principles of andragogy noted by Knowles's theory (Knowles et al., 2005, p. 4).

Andragogy has six core principles that guide the design and process of adult learning and should all be present to have the learning be a more effective learning process (Knowles et al., 2005). The principles are: (a) need to know, (b) learner self-concept, (c) learner's experience, (d) readiness to learn, (e) orientation to learning, and (f) motivation to learn (p. 141). These principles, based on research in learning theories and behaviorist and cognitivist/gestalt thinking, help delineate the adult learning process as different from the pedagogical learning of a child (Knowles et al., 2005).

Knowles (2005) argued that pedagogy and andragogy incorporate intrinsic assumptions about learners. There are four main assumptions that demonstrate the difference between andragogy and pedagogy. They are: (a) changes in self-concept, (b) role of experience, (c) readiness to learn, and (d) orientation to learning (Knowles, 1973, p. 45). In Knowles's first assumption, changes in self-concept, andragogy assumes that individuals grow and develop their self-concept to essential self-direction, which characterizes that they have psychologically become an adult (p. 45). If there is a psychological need for adults to present themselves as self-directed and they are in a situation or learning environment that does not allow them to be self-directed, this can create a psychological tension between that situation or environment and their self-concept (Knowles, 1973). If adults enter into a job or educational situation, they have

most likely already taken that large step and see themselves as self-directed and identify themselves within that adult role. If the job or educational situation puts them in the position of being treated as a child, this can interfere with their learning processes and hinder their success (Knowles, 1973, p. 45).

Knowles's (1973) second assumption is the role of experience in andragogy. Andragogy assumes that the adult has a large bank of experiences from which they can pull and relate to new experiences and new learning situations. This is where Knowles's thought traditional modes of pedagogical teaching in which the student is an empty vessel to be filled decreases and there is an increased emphasis on experiential learning techniques and strategies such as team project collaboration, simulations, discussions, and laboratory experiments. Knowles's believed that children tended to have less experience and depend upon the teaching of others to help define themselves and their experiences. Adults, in Knowles's second assumption, tended to define who they are based on their experiences and view their experiences as a learning resource and a part of who they are. Rejecting their experiences can be viewed as a rejection of who they are (Knowles, 1973).

The third assumption, established by Knowles (1973), is readiness to learn. Knowles's andragogy assumes that adults' readiness to learn was based on the developmental tasks required to learn and achieve their evolving social roles. Where children may be learning what they have to learn based on where they are in their biological and cognitive development, adults are learning what they need to learn by the

nature of the developmental tasks they need to achieve for whatever social roles they may be entering (e.g., their social roles as employee, spouse, parent and such; Knowles, 1973).

The final assumption of Knowles's (1973) andragogy was orientation to learning. In this assumption, children tend to be taught from a subject-centered orientation where they are learning content with the intent of postponed application, whereas adults are taking a more problem-centered orientation in which they approach education due to some type of inadequacy in some life situation. They want to learn something and be able to apply it immediately towards the life situation (Knowles, 1973).

These assumptions of andragogy and pedagogy established by Knowles have different meaning and foci for curriculum and program development in academics since children and adults approach education for different purposes, levels of readiness, levels of self-direction, and experiences, the way they learn and are being taught should be adjusted accordingly. Knowles (1973) theory of adult learning took into account these assumptions in six core principles.

In Knowles's (1973) first core principle of andragogy, the need to know, learners needs to know the why, what, and how of learning. Within pedagogy, learners learn only what the teacher believes to be valuable (skills, knowledge) in order to get a grade and be promoted. With andragogy, the need to know for adult learners is to have a relevant need in their life to learn the information. Adults can see how this learning is relevant in their life at the time they need it. Understanding why they need to learn something, what it is they are learning, and how it is connected to their overall purpose makes the learning

relevant and can help motivate an adult learner to learn a particular topic (Knowles et al., 2005, p.149).

Knowles's (1973) second core principle was the learner's self-concept. At the pedagogical level, the assumption about learners was that they are dependent and directed by the teacher. In this second principle, the learners do not see themselves as having the skills or knowledge to be self-directing, and therefore remains dependent upon the teacher (or other authority figures) as the rate of growth progresses. With adult learners, this assumption in this core principle is that they are already self-directing in their self-concept. They have learned to be autonomous, are aware and willing to be responsible for their own lives and choices. Here they may have a strong psychological need to be seen by others and treated by others as being capable of self-direction (Knowles et al., 2005, p. 65).

The third core principle of andragogy, as established by Knowles (1973), focused on the role of adult learners' personal experiences in their learning. Adults who return or come to higher education for the first time have a varied and typically larger scope of experiences than a traditionally aged student immediately after high school graduation. Adult learners may have had a career or two, a family, and various experiences from hobbies and travel. These experiences can make a difference in the quality and quantity of adult learners' education (Knowles et al., 2005). When learning a particular subject or discussion of a topic they may have some familiarity with, Knowles believed adult learners could use that experience to scaffold to the new learning concept. They could draw comparisons to their experiences with the new learning. This is where experiential

learning techniques such as group discussions, simulation exercises, problem-solving activities, case methods, laboratory methods and peer-helping activities can make a difference in learning (Knowles et al., 2005; Kolb et al., 1999). These experiential learning techniques, noted by Kolb (Kolb et al., 1999), can draw from adult learners' past experiences, as adult learners tend to define who they are by the experiences they have had, as established by Knowles (1973). When their experiences are not considered or valued, adult learners may take that as a rejection of who they are (Knowles et al., 2005). As Knowles observed, at the pedagogical level, young learners define themselves by external forces such as their peers, parents, and other adults in their lives. Their experiences are typically formed for them; they have not had the time to develop the diverse quantity of experiences to help form and develop their learning. Their scaffolding of knowledge comes from previous experiences formed for them by others.

Andragogy's fourth core principle- readiness to learn- was associated with the developmental tasks or stage in which adult learners are currently (Knowles et al., 2005). The knowledge, as observed by Knowles, needs to be available at the time the learner is in the developmental stage to learn it. When adult learners are faced with a situation or problem that needs to be addressed, they are more likely to be ready to learn in order to help solve it. Knowles et al. (2005) indicated that one does not necessarily have to wait for a developmental stage to occur naturally in order to learn. There are ways to induce readiness by exposure to "models of superior performance, career counseling, simulation exercises, and other techniques" (p. 67). For pedagogical or andragogical learners,

curriculum that induces readiness with appropriate exercises can help their learning process.

The fifth core principle was orientation to learning (Knowles et al., 2005). Where the pedagogical learner's orientation to learning is subject-centered (history, math, writing, etc.), the andragogical learner's orientation to learning is life-centered (or task-centered or problem-centered; Knowles et al., 2005). Adult learners, in Knowles's theory, are more apt to learn new information, skills, and values necessary or that are relevant to solving, doing, or achieving the particular problem, task, or life situation that they will come upon in real-life situations. Having curriculum structured so that the new knowledge is linked or can be applied to real-life situations increases the likelihood that an adult learner will be successful in learning and retaining that knowledge. An example relevant to this dissertation research is that adult learners are most likely willing to learn and remember math that has a life-centered approach, such as learning to balance their checkbook, calculate taxes and determine mortgage rates.

Knowles's (1973) final andragogy core principle was motivation. While both an andragogical learner and pedagogical learner can be motivated by external forces such as grades, degrees, and scholarships, andragogical learners have perhaps a stronger internal pressure and motivation such as their desire to increase job satisfaction, quality of life, and increase self-esteem (Knowles et al., 2005). Additional external motivations for adults can be better career choices, higher salaries, and promotions. These external motivations may be the push for the adult learner to pursue additional training or

schooling, yet the adult learner will most likely to use internal motivations to engage and persist in the learning.

Umoh, Eddy, and Spaulding's (1994) study about factors that influenced retention for students in developmental math found that a factor such as academic goal commitment was not significantly different from students in college-level math; yet the researchers concluded that most of the students in the study had the academic goal to graduate, believed it to be important and performed academically as anticipated towards that goal (p. 42). The researchers used Tinto's model of institutional departure for their conceptual framework for the study. Based on this, the researchers considered goal commitment as a product of college readiness characteristics and as a form of academic integration (Umoh et al., 1994, p.40). The sample population was randomly selected from enrollees in a developmental mathematics course in a southwestern United States urban community college. Forty-one students from the original 56 student sample completed the survey. Some variables such as age were not significantly linked towards the retention of students in developmental math courses. The researchers concluded that these variables examined "primarily influenced retention decisions through direct effect on students' intentions to go through the developmental education mathematics programs in order to open other doors" (Umoh et al., 1994, p. 45).

In essence the motivation of the students to succeed through the developmental math courses was directly affecting the students' retention decisions (Umoh et al., 1994). They knew they needed to complete the developmental math program in order to have access or open other opportunity doors for themselves. Students understanding the

sequence of math courses needed to achieve their goal, and understanding the academic integration of these basic skills math courses for their goal seem to be good indicators of their successful completion. In practical terms, making sure students in basic skills math courses understand the purpose of these courses towards their goal and the sequence involved that will get them to their goal can help their retention and success in these courses based on applying Umoh et al.'s (1994) study results to this dissertation study.

More recently, Mesa (2012) found when surveying 777 students enrolled in remedial and college-level math courses at a community college that their achievement goal orientations were consistent with their adaptive learning patterns. The students who were interested in developing self-competence, demonstrated a positive math self-concept, avoided self-defeating behaviors, and expected and believed they could handle challenging work tended to have higher achievement goal orientations. The sample was selected by 25 of the 70 mathematics teachers administering the survey in their classes. The survey was administered in or to 40 sections of ten courses between the fall 2009 and fall 2010 semesters.

Mesa (2012) used an instrument developed from items taken from two other scales focused on adaptive learning and mathematical behaviors in additional to demographic information (p. 54). The instrument focused on student mastery and performance, teacher mastery and performance, academic persistence and self-efficacy as well as student self-handicapping behaviors. Since the scale was an adaptation, Mesa did a factor analysis and analyzed the internal consistency and reliability of the scores from

the scale using Cronbach's alpha. The true score variance of the items in the scale were .71 to .89 and considered appropriate for analysis.

The study limitations were (a) it was a single-institution study, (b) the study focus was on students taking math courses vs. all students in the college, (c) there was a small sample size of participating instructors (n=15), (d) there were no final academic outcome measure to relate scales to academic performance, and (e) there is a potential social desirability effect of self-report measures. The author believed that regardless of these limitations, the study provided a "counterintuitive view of the achievement goal orientations that the students in this college have, which might resonate with students in other colleges" (p. 59) and might encourage instructors to look for opportunities to utilize and capitalize on the goals students bring with them to their math classes (Mesa, 2012).

Achievement goal orientations are the students' reasons or purpose for undertaking the particular academic behavior as well as the standards used to assess performance. This model of achievement motivation supports andragogy's fifth principle of motivation that students whose goals were more oriented towards developing competence and understanding rather than satisfying external factors were in an orientation that has been associated with higher student academic achievement (Mesa, 2012, p. 59).

Knowles et al. (2005) contended that adult learning was the process of adults gaining knowledge and expertise, yet that there can be issues that contradict this ideal idea of adults controlling their own learning process and the reality of their limitations in taking control of their own decision-making (p. 174). They suggested that andragogy

principles could be applied in part or in whole with the understanding that the essential feature of the theory is flexibility (p. 146). If an educational situation calls for a more pedagogical assumption for a particular learner in order to learn the particular goal, then the instructor needs to adapt and apply the necessary skills and strategies that support that assumption rather than the andragogical assumption. For example, adult learners with absolutely no experience with a particular content would be completely dependent on the instructor to help guide and form their learning. Therefore, a pedagogical assumption may produce a better instructional method for the learner in that context. The important consideration is whether the instructor remains aware and is able to be flexible in instruction.

Knowles's (1973) original theory continues to be a theoretical foundation for community college and other higher education researchers and professionals. Chaves (2006) in a review of theoretical tools in the involvement, development, and retention of adult community college students discussed how some major theories when taken together could provide a framework for improving adult education in the community college systems. Both Knowles's (1973) theory of andragogy and Kolb's (1984) theory of experiential learning were discussed and described as major curricular theories for adult learners. Chaves (2006) believed based on his review of the theories that taken together, these two theories in curriculum development allow adult learners to "understand what they already know more deeply and, more important, learn what new knowledge they have yet to learn" (p.148).

Kolb's Experiential Learning Theory

Kolb's (1984) experiential learning theory is the second component of the conceptual framework for this study. It can encompass several aspects such as service learning, work-based learning, and problem-based learning (Kolb, Boyatizis, & Mainemelis, 1999). Kolb's (1984) theory emphasized that learning should be viewed as a continual process grounded in experience. The experience is the basis for the cycle of learning where a student learns by doing (active experimentation), by feeling (concrete experience), by watching (reflective observation), and by thinking (abstract conceptualization; Kolb, 1984). Two modes on the continuum of grasping experience (feeling, or concrete experience and thinking, or abstract conceptualization) interconnect with the continuum of transforming experience (watching, or reflective observation and doing, or active experimentation; Kolb, 1984). In Kolb's theory, with the continuums of grasping and transforming experiences, students can choose the set of learning abilities for any given situation. The continuum is fluid and not a static set of abilities that are used for each learning situation. So students in one learning situation may grasp their experiences through feeling, relying on their senses and awareness of the tangible concrete aspects of the situation; whereas, students in another situation may rely more on grasping the experience through thinking about it, analyzing or doing systematic planning rather than relying on their senses and feelings. This will vary by not only the situation but also the individual student.

This would be the same within transforming the experiences, through watching others experience the situation and then reflecting on what was happening; or, doing by

jumping in and getting started in any particular situation (Kolb et al., 1999). The student is not required within this learning process to only have one set of learning abilities, yet through experiences and preferences, he or she chooses which learning abilities to use. This is what is termed as *learning styles* (Kolb et al., 1999, p. 4).

The four learning styles identified in Kolb's experiential learning theory are diverging, assimilating, converging, and accommodating (Kolb et al., 1999). Learners who tend to prefer the diverging style use feeling and watching (concrete experience and reflective observation). These learners tend to have broad cultural interests, they are interested in people, they are most likely imaginative and emotional, they like to gather information and to work in groups, participate in brainstorming sessions, and they tend to specialize in the arts (Kolb et al., 1999). Assimilating learners tend to use their thinking and watching (abstract conceptualization and reflective observation) more dominantly. These learners tend to be best at understanding wide ranges of information, working in concise and logical formats, tend to be less focused on people and more interested in ideas and abstract concepts (Kolb et al., 1999). Assimilating learners tend to focus more on information and science careers and prefer having time to think things through and in formal learning environments, readings, lectures and exploring analytical models (Kolb et al., 1999).

A converging learner uses thinking and doing (abstract conceptualization and active experimentation) dominantly in learning situations (Kolb et al., 1999). Based on the description, these learners would seem like to find practical uses for ideas and theories, prefer to solve problems, make decisions based on the solutions to the problems

or questions. They prefer to work with technical tasks and problems rather than social and interpersonal issues. These learners prefer the technology and specialist careers (Kolb et al., 1999).

The accommodating learner uses feeling and doing (concrete experience and active experimentation) in learning situations, according to Kolb et al. (1999). They like to learn by hands on experiences, using their instinctual or "gut" feelings rather than analysis and logical processing. They like to carry out plans, engage in new and challenging experiences, and tend rely more on people for information rather than their own analysis. These learners tend to work with others collaboratively, set goals, do field work and test out approaches when solving a problem or completing a project. These learners tend to gravitate more towards action-oriented careers such as marketing or sales (pp. 6-7).

McClellan and Hyle (2012) used Kolb's experiential learning theory as well as the underlying concepts from Knowles's (1973) adult learning theory in their study that explored doctoral students' experiences and the effects of their understanding of qualitative research. They studied sixteen doctoral students from a Midwestern university in a doctoral level research course within a summer cruise. They used the participants' observation field notes and their reflective journaling as part of their data collection. Through this process the researchers were able to facilitate their students' progress through the four-stage cycle of experiential learning. They were given opportunities to engage in reflective observation, abstract conceptualizations, active experimentation, and concrete experiences in order to explore how the experiential education can influence the

students' learning during real-world collection and analysis of qualitative data (McClellan & Hyle, 2012, p. 240).

There were three themes that emerged from the McClellan and Hyle (2012) study (a) learning within a foreign context was more enhanced than within a traditional classroom, bringing excitement, fear, growing confidence in self-belief, deeper self-awareness, and development of keen observation skills as well as frustration for the difficulties that accompanied learning outside the traditional classroom such as time management and even weather; (b) experiencing teamwork; and (c) learning about research, specifically around data collection. This study demonstrated the value of experiential learning within a higher education course. It also connected how when students may have a lower level of prior experiences, a carefully developed and intentional experiential education can increase learning and engage the student. This demonstrated Knowles et al.'s (2005) core principle in andragogy about prior experiences as the building block for many adult learners to be able to learn and engage more effectively.

More recently, McLeod (2013) used Kolb's (1984) theory to develop experiential learning with undergraduate students in a small group communications course. Course structure and exercises involved in-class assignments replicating published research on a given topic. The author had used group collaboration tasks, manipulation of variables (replicating published research), collection, and analysis of data (p. 360). McLeod's primary objective was to improve students' abilities to communicate and use specific decision-making techniques. Assessment of the objectives included use of written paper

assignments and performance on course examinations, as well as the students' open-ended responses to a formalized end of the course evaluation.

McLeod's (2013) results demonstrated that students self-reported that they were putting concepts learned from class into immediate practice along with learning more from the class, which was supported by the average semester grade of A-, with a range of B- to A+ (p. 372). Further follow-up from students who had previously taken the course found that the students continued to integrate lessons learned from the course into work and personal lives. This, in turn, has helped the students' job performance, personal development, information sharing, and ability to recognize expertise in their working groups. (p. 374). This study, which uses Kolb's (1984) theory of experiential learning demonstrates how Kolb's ideas can be infused into content course development and has enduring effects in students' learning of concept, theories, and application.

UDL as Conceptual Framework

The third component of the conceptual framework that is used for this study is the framework of UDL with the relation of basic skills inquiry (Illowsky, 2008). With theories related to andragogy (Knowles, 1973) and experiential learning (Kolb, 1984: Kolb et al., 1999), this intersection provides a view of the study from these standpoints to help frame the understanding of the phenomenon of the experience of instructors teaching basic skills math with a UDL technology tool.

Universal Design (UD) is the "design of products and environment to be usable to the greatest extent possible by people of all ages and abilities" (The Center for Universal Design, 1998, p. 2). UD then moved from the realm of architectural work of physical

spaces to the nature of the classroom in the 1990s under additional terms such as Universal Design in Instruction (Morra & Reynolds, 2010) and the more commonly used UDL (Rose & Meyer, 2002). The idea of inclusion for all students was a concept that had been building momentum in the K-12 system, especially within the special education arena (Rose & Dalton, 2009). Technology has been incorporated into UDL as technology's use in teaching and learning are efforts to maximize the learning and engagement of the students with a wide and diverse range of skills and abilities (Rose & Meyer, 2002).

UD incorporated seven principles that act as guidelines when designing the physical environment or products to provide the widest use for a diverse range of abilities (Center for Universal Design, 1998). When incorporated into learning design, they (a) make products and the physical environment useful and marketable to diverse abilities, (b) are able to be used in a wide range of preferences and abilities (flexibility), (c) are easy to use regardless of the user's level of skill, experience, language skills, knowledge base or concentration level, (d) provide information regardless of the users' sensory abilities (such as low vision, hard of hearing, etc.), (e) can be used comfortably with minimum fatigue, and (f) are adequate in size and space regardless of the user's body, size, posture or mobility. Additionally, (g) the design should have minimal errors and adverse consequences of unintended actions with the product or environment (Center for Universal Design, 1998).

As UD was moved into the education field in the 1990s, the seven UD principles were blended and merged into three main principles that embody the concept of UDL,

which are multiple means of representation, multiple means of expression, and multiple means of engagement (Rose & Dalton, 2009). UDL involved three different networks of the brain that work together to help an individual's learning: The recognition networks of the brain, or the "what" of learning, is basically how we use our senses to gather facts and recognize what to do with the information (CAST, 2014) or the multiple means of representation. The strategic networks, or the "how" of learning, concerns planning and performing tasks and how learners organize ideas and expresses them. This is the UDL principle of multiple means of expression (CAST, 2014). The third principle covers multiple means of engagement, which uses the brain's affective networks, or the "why" of learning. This is how the learners get engaged and motivated, stay excited, challenged, or interested in what is being taught (CAST, 2014). The strategies, techniques, and curriculum design of UDL were originally used to address the varied learning levels and needs of students with learning disabilities and help promote retention and success of learning (Rose & Meyer, 2002).

These UDL principles change the way that curriculum is designed, taught, and assessed, as well as how students engage within the curriculum activities. The UDL tool that was incorporated into a basic skills math pilot project (SULP, 2012) was a computerized pen referred to as a Smartpen, which captures visual and auditory information. This computerized Smartpen utilizes two of the three UDL principles: multiple means of representation and multiple means of engagement. In the research concerning UDL discussed in the literature review section of this chapter, it was clear that UDL is demonstrated in various ways in classroom activities.

Rationale for Conceptual Framework and Relationship to the Study

Both Knowles's (1973) and Kolb's (1984) theories parallel the principles behind UDL, where the need for flexibility and adapting to the needs of the learner are shared. These two theories and UDL principles are adaptable to the learners' level of need. It would appear that the use of the UDL and its technology tools and methods of instruction would address some of the andragogical assumptions for the diverse age group of basic skills math students. Knowles's (1973) six core principles can help inform the framework of understanding on the experiences of the instructors who used UDL and a Smartpen for teaching basic skills math. These aspects of UDL's principles of multiple means of representation, expression, and engagement can be related to what Knowles's theory says about adult learners needing to know the what, how, and why of learning in order for their learning to occur (Knowles et al., 2005; Meyer, Rose, & Gordon, 2013).

Experiential learning theory was based on the assumption that ideas are fluid and are formed and re-formed through experience; concepts are developed from and continually shaped by experience (Kolb, 1984). Since experiences vary from individual to individual, the process of learning cannot be fixed and defined by an outcome (p. 26). The instructor's main purpose cannot be to present a set list of concepts, terms, or outcomes that can be recited, but to implant or facilitate new ideas and dispose of or modify old ones (Kolb, 1984, p. 28).

Knowles's (1973) and Kolb's (1984) theories have a stronger connection to each other when looking at particular principles noted in the andragogy theory. Knowles et al.'s (2005) third principle, prior experiences of the learner, suggested that experiences

aid in learning new knowledge when it is presented in a way that can connect to existing knowledge and mental models (p. 194). The theory of experiential learning contends that learning is a continuous process grounded in experience (Kolb, 1984). Knowles et al. (2005) also noted the strong influence of Kolb's model within the orientation to learning principle. Here, Kolb's four modes of the model provide the essential framework for designing learning experiences for adults (Knowles et al., 2005). They can be used on a macro-level when programs and classes are structured to include the four modes as well as at the micro-level when the modes can be included as units or lessons (Knowles et al., 2005, pp. 197-198).

One area of understanding about the instructors' experiences in basic skills math could include how they perceived their students' learning styles. Using these two theories and the UDL principles as conceptual framework can provide a way to understand how adult learners may cycle through the learning of basic skills math. This could support the understanding of educational needs for both traditionally aged students and adult learners' including the instructors who are learning and experiencing a new approach.

Literature Review

The three themes covered in the literature review for this study are (a) UDL curriculum, course design, and technology, (b) student and faculty perceptions of UDL, and (c) current approaches to teaching postsecondary basic skills math. In the UDL curriculum, course design and technology theme, studies examined how UDL had been incorporated in the community college curriculum and how technology can support UDL principles in higher education (Jackson, Gaudet, McDaniel, & Brammer, 2009; Morra &

Reynolds, 2009), as well as students' learning of mathematical concepts (Gradel & Edson, 2009; Harrison, 2006).

The second theme covers student and faculty perceptions of the use of UDL in learning mathematical concepts (Kortering, McClannon, & Braziel, 2005; Schelly, Davies, & Spooner 2011; Woodson-Day, Lovato, Tull, &Ross-Gordon, 2011). UDL has limited research in higher education; most of the research has been conducted at the elementary and secondary levels (Rose & Meyer, 2002).

The final theme examines approaches towards teaching basic skills math to postsecondary students with and without learning disabilities (Arnett & Van Horn, 2009; Heiman & Shemesh, 2012; Raines, 2012; Stern, 2012; Trenholm, 2009; Wenner, Burn, & Baer, 2011); the use of assistive technology for students with and without learning disabilities (Heiman & Shemesh, 2012); computer use in basic skills math learning (Stern, 2012; Trenholm, 2009; Wenner et al., 2011), learning communities (Arnett & Van Horn, 2009), and intensive short-term mathematical learning program students took prior to starting their math class (Raines, 2012).

UDL Curriculum, Course Design, and Technology

Universal Design for Learning (UDL) in the higher education system has various foci such as curriculum and course design, technology use and implementation, faculty and student perceptions, and the approaches to postsecondary basic skills and basic skills math learning. These foci are important to lay the research foundation for this dissertation as they all play a role in creating an inclusive learning environment for students with and without learning disabilities, as well as understanding adult learning in relationship to

basic skills math and students and faculty perspectives. Gradel and Edson (2009) found that UDL implementation strategies and models for faculty in higher education must go beyond what they learned about teaching and become more inclusive in their teaching and understanding student learning (p. 120). The faculty participants found that they had to move away from what was modeled to them by their own learning experiences. Gradel and Edson's meta-analysis study focused on a California State University's implementation of UDL strategies by its faculty. Gradel and Edson surveyed 456 undergraduate and graduate students with and without diagnosed learning disabilities to explore the students' perceptions of implementing UDL in higher education. This helped the researchers determine potential needs and challenges to the implementation of UDL strategies in the postsecondary setting.

The most essential findings for student learning were that (a) the course syllabi had to be informative and clear, (b) there needed to be multiple teaching styles and modes used to convey the course concepts, (c) creating sound pedagogical practices was essential so the student can engage and respond to the concepts by giving feedback, and (d) guidelines for assignments needed to be thorough and presented in different ways (Gradel & Edison, 2009, p. 114). Course design and mindfulness of sound pedagogical practices allow students to become more engaged and responsible for their own learning experiences. Gradel and Edison's study provided a potential model for implementing UDL concepts in higher education. This study can help faculty understand the needs and challenges that exist when developing a comprehensive program of strategies across curriculum.

Harrison (2006) also focused on course design and the development of creating a dynamic course design process. Harrison used Universal Design for Instruction (UDI) to focus on the environment in which the student was being asked to function. Harrison's paper focused on shifting from specialized instruction and accommodations provided for students with learning disabilities to the overall environment in which the students with learning disabilities were living and learning. This shift in focus was on Learner-Centered Education where instructors were encouraged to be facilitators of learning and be more purposeful in their assessment of student learning. The dynamic course design worksheet that was created merged the Learning-Centered Education (LCE) and Universal Design (UD) principles together that allowed instructors to create equitable access learning and instruction for all students. Implementing heuristics such as this process can be helpful for training faculty in implementing UD principles within their curriculum and learning environment. Harrison's (2006) heuristic worksheet provided four steps in this dynamic course design: (a) identifying overall goals, (b) determining learning objectives or performance measures, (c) designing assessment activities, and (d) moving toward a Universally Designed course (pp. 160-162). It can help provide one small change at a time for instructors and not make the process of course redesign to be as daunting a task as it could be (Harrison, 2006).

More recently, Morra and Reynolds (2009) reviewed their own hybrid and online courses that were technology enhanced to identify course strategies and materials that supported the UDL principles. The authors applied the principles of UDL in their review by seeking information for this question: how are UDL learning principles and options

used in technology-enhanced courses such as hybrid or online courses? (p.44). In their review of the lead author's hybrid and online courses, they sought evidence that identified course strategies and materials that supported the three UDL principles: multiple means of representation, multiple means of engagement, and multiple means of expression (Rose & Meyer, 2002).

Morra and Reynolds cited examples within the course assignments and syllabi that demonstrated elements of the three UDL principles, such in a small group assignment in one online interpersonal communications course. The requirement of providing students with a small-group experience was implemented by giving the students a choice in how they completed their group requirement. An alternative or individual group assignment was a choice recognizing that not all students are interested in or like working in a group with classmates. This individual assignment allowed students who chose it to analyze a group in which the student was a member (such as a work or personal group). The choices allowed students to engage in the assignment based on their individual interest, motivations, and needs (Morra & Reynolds, 2009). Based on their review of the three UDL principles and their presence in their technology-enhanced courses, the authors suggest that using technology for course design and delivery is an effective way to provide a flexible learning environment, reduce learning barriers, and support the needs of their learners (p. 49).

These studies highlight the important aspects for the development of UDL course design. Additionally, Jackson, Gaudet, McDaniel, and Brammer (2009) examined the integration of technology with learning and curriculum. This study examined Gardner's

(1983) Theory of Multiple Intelligences that highlights strategies in learning that uses UDL principles. Gardner's (1983) theory of multiple intelligences suggested that there are seven different types of intelligences that all people possess and use in daily life and learning; however people often have strengths in one or more of the intelligences. For example, people who have strengths in Bodily-Kinesthetic Intelligence may be gifted athletes and learn best through use of their body and hands-on activities. They seem to have a more natural sense of their body and its connection to the physical environment around them (Jackson et al., 2009, p. 73). When applying multiple intelligences to the principles of UDL, students with strong bodily-kinesthetic intelligence would benefit in learning by doing, such as participating in group activities and possibly activities that require dexterity, balance, coordination, and such while involving their hands and body to learn the concept. They may also use their body and these types of tangible skills to show what they know about the information, whether development of a physical project that represents the subject, acting it out, or creating an interactive Power Point presentation rather than taking a test.

Jackson et al.'s study (2009) examined Gardner's (1983) theory also incorporated understanding the diverse backgrounds that students bring to their higher education institution. Students come to higher education at a variety of backgrounds and ability levels. Using students' strengths or diverse abilities can help their learning and is a fundamental essence of UDL (CAST, 2007). Jackson et al. (2009) suggested that problem-based learning (PBL) could be an effective way for students to learn; one that engages students to formulate and solve real-life problems (p. 76). This approach of PBL

in teaching is UDL inspired that can keep students engaged and involved in their learning. It is also a way to approach learning and/or solve the problem in their own way to maximize their learning.

The use of technology can improve access and curriculum delivery. Incorporating technology into curriculum can help engage students' multiple intelligences and allow for them to support and integrate the principles of UDL into their learning. When considering this dissertation study, the use of technology to engage students' diverse learning styles and incorporate the UDL principles seems to be supported (Morra & Reynolds, 2009; Rose & Meyer, 2002). Technology as a vehicle to support face-to-face instruction is just one of the ways it can be used in higher education.

Student and Faculty Perceptions of UDL

In addition to the use of UDL within course design, curriculum, and technology, student and faculty perceptions about UDL are important to the successful use and implementation of UDL. Schelly et al. (2011) conducted a study to measure the effectiveness of faculty training in UDL as perceived by the students' perceptions of the UDL implementation (p. 19). Students completed a questionnaire before and after the UDL training and implementation focusing on classroom instruction and course materials. Five psychology undergraduate courses (nine sections) at a central United States university were used for the study. The classes were surveyed pre- and posttraining. The training for the faculty was designed based on areas that students' average responses were below four points (below "agree" on the Likert scale) in the pretraining survey. Training consisted of information and tips on converting course

material into various electronic formats, as well as presenting material in a variety of formats (e.g., lecture, text, graphics, video, and audio) and ways to engage students in the learning process.

There were five instructors and students within the nine sections of Introduction to Psychology who participated in the Schelly et al. (2011) study. There were 1,615 students in the nine sections of psychology classes. 1,362 students completed the pretraining survey, and 1,223 students completed the posttraining survey representing a 76 percent response rate. Descriptive statistics were used for demographic information. The authors used *t*-tests to compare students' perceptions of their instructors' use of UDL strategies before and after the UDL training (p.20).

One of the demographic questions used by Schelly et al. (2011) was designed to identify if a student had a disability. In this study, 106 students (8%) who reported they had a disability (learning or other disability) on the pretraining survey. Only 23 of these students (22%) indicated they were receiving services from the university's disabilities office. On the posttraining survey, 98 students (approximately 8%) disclosed having a disability, 20 of those students (20%) received services from the disabilities office (Schelly et al., 2011). The percentage of students who actively received services and accommodations through the university's disabilities office were a much smaller subset of those students who identified as having a disability. This suggests that there is a significant percentage of college students with undiagnosed learning disabilities or who have a learning disability and do not wish to disclose (Schelly et al., 2011). These students do not receive services because of the lack of documentation or awareness of

services and thus may struggle academically. Incorporating UDL principles within college classes can possibly lessen the impact of students' learning disabilities or learning challenges for those students who do not self-disclose their disabilities. It also stands to reason that it can assist students with undiagnosed learning disabilities, along with students who have no learning disabilities.

Schelly et al.'s (2011) results indicated that students reported a significant increase in their instructors' use of UDL strategies. This demonstrates the effectiveness of the training of instructors in UDL principles and their ability to integrate them immediately within a classroom situation. However, this study was not able to evaluate how the UDL instructor training impacted students' perceptions about their own engagement, or even their academic success. These results specifically examined the students' perceptions on the changes within their instructors, such as their presenting ideas and information, engaging students, and allowing students to express their comprehension of course content in a personal meaningful way (Schelly et al., 2011, p. 25).

Schelly et al. (2011) believed that the results of this research were promising and indicated that training higher education instructors in UDL principles and implementation strategies may enhance the learning experiences of all students (p. 26). This also indicated the ease of making curricular changes within the course after UDL training had occurred and can suggest to instructors that a complete course overhaul may not be necessary and warranted to be able to implement UDL principles within their courses.

Kortering, McClannon, and Braziel (2005) also studied student perceptions of UDL, specifically with Algebra and Biology students in the high school setting. This study used two high schools in adjacent counties in North Carolina. There were team participants of six algebra and five biology teachers that used UDL in varying degrees. The teachers participated in two to four full day training sessions that provided technology (laptop computer, video projector, digital camera and camcorder) as well as hands-on use of technology and practice with UDL-related resources in the classroom (Kortering et al., 2005). There were 320 student participants (100 in algebra and 220 in biology) who were exposed to one to six different interventions depending on their teachers' training and class setting. Surveys were given at the end of each class when a UDL intervention took place for a total of 709 responses. The surveys were both closed-ended (Likert scale) and open-ended questions.

Kortering et al., 2005 found that 90% of the participants wanted access to more UDL interventions and students both with and without learning disabilities reported favorable views of the UDL interventions. Open-ended question responses indicated that the interventions were rated as better than what was experienced in other academic classes, and suggested that students believe UDL interventions help with learning and using technology as an effective tool (Kortering et al., 2005, p. 4). Despite this focus on secondary students, this study's results provide implications towards the use of UDL in math and biology courses, as well as how it can be viewed as a tool for changing how instructors think in terms of curriculum access and student success (Kortering et al., 2005). If instructors are hesitant to change their teaching style, the goal of better access

and possible increased student success can be a way to help them adopt innovative strategies of UDL and be able to redefine them to fit their own needs and teaching situation.

Considering faculty perceptions and how those impact the level of student learning within the classroom situations, Woodson-Day, Lovato, Tull, and Ross-Gordon (2011) explored faculty perceptions of adult learners (25 years and older) at a large two-year community college and a large four-year state university. The study also explored faculty's understanding of adult learners' characteristics as well as the faculty's preparation to teach them and how the faculty modified their teaching strategies in response to the needs of adult learners. This qualitative study collected data from the institutions in south Texas that served a predominantly Latino student population and community. A total of eight faculty members were selected as a purposeful sampling of the faculty who met the study criteria (taught at least five years of college-level teaching including experience with teaching adult students).

Results were within three major themes: (a) conceptions of adult learners, (b) teaching adults, and (c) preparation for working with adults (Woodson-Day et al., 2011, p. 79). Faculty tended to view the adult learners as tenacious, multi-tasking and well prepared. In teaching adult learners, faculty looked to build upon the life experiences of their adult learners to be able to engage them, build and connect their learning to previous experiences and learning, scaffolding their knowledge. Faculty indicated that they had to work to provide active teaching-learning strategies to help engage their adult learners and help provide them structure as their adult learners tended to be organized and wanted

content to be clear and concise (Woodson-Day et al., 2011). With their own preparation for college teaching, the faculty found that their own experiential learning in the classroom helped them develop models for effective teaching of adult learners (Woodson-Day et al., 2011, p. 81).

Implications of Woodson-Day et al.'s (2011) study to this dissertation study demonstrate that how the faculty can utilize the skills and abilities adult learners bring with them to enhance the effectiveness of their learning. If there is understanding of the characteristics that some adult learners bring with them to the learning situation, such understanding can help higher education professionals create appropriate faculty training programs as well as using relevant UDL principles that allow learners of all types to utilize the UDL strategies for academic success.

Postsecondary Approaches to Basic Skills

When UDL is considered and implemented in a postsecondary educational environment, students have the potential to learn without focusing on their learning disability. With the multiple means of representation, engagement, and expression, students who have learning disabilities, documented or not, are presented ways to learn, be motivated, and to express what they know in ways that highlight their learning strengths rather than disabilities (Rose & Meyer, 2002). Although use of UDL may not eliminate the need for accommodations, it may lessen the amount and types of accommodations that are utilized for some types of learning disabilities (Center for Universal Design, 1998; Rose & Meyer, 2002). Colleges and universities have taken

various approaches to responding to the basic skills needs of their students, both in general and in particular with basic math skills.

One of the ways to successfully serve postsecondary students is to incorporate the use of assistive technology. Heiman and Shemesh (2012) studied students with and without diagnosed learning disabilities in relationship to usage patterns of website courses and assistive technology and whether that usage contributed to the perceived well-being of students with learning disabilities and their plans to meet their desired goals (p. 311).

Heiman and Shemesh (2012) used 964 undergraduate students at a higher education distance learning institution in their study. Age range was 17-57 years of age. There were 363 students with a learning disability and 601 students without a documented learning disability as a comparison group. The return rate for the questionnaires was 63.3%. A multivariate analysis of variance (MANOVA) was used on the dependent variables: contribution of the use of online course, usage patterns of website course, the usage of assistive technology, hope and well-being (Heiman & Shemesh, 2012).

Students with learning disabilities tended to use more and be more comfortable and familiar with assistive technology than students without diagnosed learning disabilities (Heiman & Shemesh, 2012). Students with documented learning disabilities were more satisfied with the academic and social aspects of web courses. The researchers also found that many of the students without diagnosed learning disabilities often used the assistive technology for services that facilitated their studies such as spell-

checker, background management, large print, and more. These students without diagnosed learning disabilities seemed to benefit from the technological facilities and perceive global use of the web courses and the assistive technology as integral tools in their academic studies (p. 315). The use of web courses and assistive technology was familiar to students with learning disabilities. This study showed the importance of assistive technology in general and in online coursework for students with learning disabilities. It raised the importance of being aware of the needs of students with learning disabilities when developing and implementing online learning and website design. It also illustrated that UDL as purposeful design can benefit students without documented learning disabilities (Heiman & Shemesh, 2012, p.316).

Offenstein and Shulock (2010) identified the political and policy barriers to basic skills education in the CCCs, and posited that despite its strengths, the basic skills initiative was limited by the policies the system and state have that were not aligned to the goals of the initiative (p. 163). Their research, based on a meta-analysis of their basic skills initiative program, determined that the policies in place act as a barrier to student success because they limit the preparation of incoming students or they limit/slow down the progress of new students in the community colleges (p. 163). Matriculation policies establish assessment and placement of students as advisory, not a requirement. Students who are degree-seeking and placing into basic skills are suggested and not necessarily required to take the basic skills classes that set them up for success academically now and later. Additionally, the college districts' local flexibility allows for variety in placement exams to be used and cut off scores, which gives an inconsistent message to the K-12

systems about appropriate preparation for success at the community colleges. This, along with the difficult process of establishing prerequisites for college-level classes outside of the discipline, provides barriers to success for basic skills students by not requiring they complete basic skills courses prior to enrolling in college-level courses. Despite its strengths, the basic skills program has no way to ensure the students who need it are getting the help they need to be successful in college-level coursework (Offenstein & Shulock, 2011).

In an approach to teaching basic skills math at the postsecondary level, one college created an interdisciplinary approach also called a learning community for their intermediate algebra and general biology course (Arnett & Van Horn, 2009). The learning community was created based on a survey administered to first-time students in 2003 that indicated students liked their biology courses but not math courses. As the popular majors such as wildlife biology and ecology both require a foundation in biological and mathematical concepts, the instructors were concerned about the lack of mathematical appreciation and connection of their students. The instructors addressed the problem by searching out collaborations that would demonstrate to students the relevance of math to science (Arnett & Van Horn, 2009).

In the Arnett and Van Horn (209) study, the cohort-based learning community was created for first-year students that linked classes around an interdisciplinary theme. The learning community cohort received additional algebraic lessons within the context of their biology lessons. The learning community was taught each fall semester since 2003. The students who needed both general biology and intermediate algebra were

encouraged to take the learning community upon arrival. Some students who needed both courses but did not want to be in the learning community were allowed to take both classes and were identified in the study as the control group. Both groups were first semester freshman taking the same courses with the same instructors, except that some algebra was taught within the context of the biology curriculum for the learning-community group (Arnett & Van Horn, 2009, p. 31). The purpose of the learning community within the study was to address the students' lack of interest in math by investigating whether they would perform better and enjoy math more if it was provided in the context of science (Arnett & Van Horn, 2009). Evaluation included final grades in intermediate algebra and students' disposition concerning math through focus groups and surveys.

Arnett and Van Horn's (2009) results indicated that intermediate algebra grades were significantly higher in the linked math-biology learning community than the unlinked math class. The fall of 2006 and 2007 grades were compared with both classes that were taught by the same instructor in the same manner; there were 43 grades used in the linked algebra and 54 grades in unlinked algebra for both years combined (p. 32). Using a numerical grade scale of an A being a 4.0, a two-sample *t*-test was used. The disposition of the students was gathered through a survey for both years, with specific focus on the biology stream module that was detailed and discussed to gather further dispositional assessment. These results indicated students who completed the linked courses had a positive attitude towards math (75% compared to 38% of students in the unlinked courses), that they understood math to be important in achieving their academic

and career goals (100% compared to 55% of students in unlinked courses), and 75% of all the students surveyed (in linked and unlinked courses) indicated that they understood math to be an important skill in life and that they felt more comfortable taking more math courses (Arnett & Van Horn, 2009, p. 33).

Arnett and Van Horn's (2009) study indicated a successful approach towards teaching math at the postsecondary level for students in a learning community. The learning community helped the students within the experimental group connect and understand the importance of math in science courses as well as in their career and life, and that their attitude towards math was more positive. As a result, providing the linked coursework with a learning community remains one approach to teaching math at the community college level. Learning communities put into practice aspects of Kolb's (1984) experiential learning and Knowles's (1973) andragogy theory. Learning communities utilize integrated experiences in the learning of content as well as application of the content learned (Kolb, 1984). This integrated learning also addresses some of the six andragogy principles such as readiness to learn, where an adult is learning math (or other content) that is immediate to the needs of the overall learning experience. For example, Arnett and Van Horn's (2009) learning community students were learning the algebra that was necessary for the linked biology course.

Another approach to teaching math at the community college level was computer-based module learning offered by a large community college in Tennessee. Stern (2012) described the approach this college applied after noting that previously only 50% of their students were passing developmental math. As of 2007, about 700 students in this large

Tennessee community college district took developmental math each year with only 54 percent of them completing the course successfully. As minimal developmental math was required to obtain a degree and to move onto the next level of math, there was a decision to redesign the developmental math course. Demographically, the average student age was 28 years old and the majority of the students worked and had families. At least one remedial course was taken by 66% of the students annually, higher than the national average of 60 percent (Stern, 2012, p. 2). The college piloted a program using their computer lab to teach developmental math. The math course was redesigned into 10 modules and studied online with the completion of each module noted by a competency exam done online. The redesigned course implemented strategies such as customized learning, utilizing technology and involvement of the student (Stern, 2012). Instructors spent their time in the math lab facilitating learning, answering questions, providing examples and prompts rather than lecturing. There were two faculty members and a tutor for a lab that had 60 computers and one professor in a lab with 20 computers.

The college found that after implementing this pilot project with the computer labs, passing rates rose from 54% to 74% (Stern, 2012, p. 2). Students working at their own pace and receiving feedback almost immediately within the computer lab provided an interactive approach towards their learning. While the passing rate percentage has increased to above 70%, it is noted that still 30% are not passing. It was suggested that 20% of the students who do not pass had stopped coming to class and the 10% who failed the first time around, passed their second time of course completion (Stern, 2012). Based on the elements of this process, it would seem that this approach was connected to the

principle of andragogy - readiness to learn. Students in Stern's (2012) study worked in at their own pace which allowed them to learn the concepts at a rate of their own readiness.

The trend of computer technology use for mathematical learning was seen in other studies (Wenner, Burn, & Baer, 2011; Trenholm, 2009). This seemed to be a more frequently used approach for teaching basic skills math as it allowed for more flexibility in the pace of student learning (Wenner et al., 2011) and helped with retention and engagement in the classroom (Trenholm, 2009).

Another approach had been the use of short term bridge programs that provided intensive mathematical learning in a short period of time as a way to frontload the learning before the actual semester begins for STEM (science, technology, engineering, and mathematics) majors (Raines, 2012). This study focused on a five-week intensive summer bridge program at a university to address at-risk STEM majors' mathematics deficiencies. The program used structured mathematics instruction, peer-led learning, individualized study plans and exposure to STEM applications of mathematics (Raines, 2012, p. 24). The findings indicated a high retention rate (91.4%) from fall to spring semesters after completing the bridge program, and a spring to fall retention rate of 77.1% (p. 26). Both rates were higher than the university's retention rate for first time freshman. Although there was no comparison data for the institution and bridge program participants for GPAs, the study findings did note when comparing the cumulative GPAs of the students with persistence, grades seemed to be a factor in a student's decision to persist from fall to spring semesters (p. 27). Summer bridge programs such as this can

provide precollege experiences and academic preparation that can help improve an institution's success and retention rates (Raines, 2012).

Wenner et al. (2011) examined technology in providing math related to the geoscience topic being studied, hence providing math right on time. This has been found to be a good approach to teaching math. Success in this study was connected to student participation and successful quantitative skill remediation. There was an increase in completion rates from 67% to 95% with an average of 84%. This TMYN (The Math You Need When You Need It) program used online modular tutorials given to students prior to learning about a quantitative concept in geoscience (Wenner et al., 2011, p. 16). TMYN draws on the necessity principle posed by Harel (1998), "students are poised for deep learning when certain mathematical skills or concepts are necessary to tackle the problem at hand" (Wenner et al., 2011, p. 18). This necessity principle increased student motivation through engagement because the modules helped create perceptions of relevance and usefulness of math in geoscience (Wenner et al., 2011).

Another consideration regarding student success in basic skills math completion, involved Zientek, Schneider, and Onwuegbuzie's (2014) exploration of the perceptions of developmental math instructors about what affects student placement and hinders student success in developmental math courses (p. 67). Understanding what instructors believed to be barriers to their students' success could assist in identifying ways that developmental education can be improved. The study used a convenience sample of developmental math faculty across six community colleges and one state college across four states. There were 79 community college instructors and 10 instructors from the state

college (p. 70). The survey conducted covered two open ended items for faculty to respond, a) describe the factors they believed made an impact on students' placement into developmental math, and b) indicate what factors they believed hindered some of their students' success in the developmental math courses.

The first theme for low placement (Zientek et al., 2014) was the time delay students had since completing their last mathematics course. Often students have a delay in education due to returning to college or academics after spending time in the work world since high school or college, or they were high school graduates whose last math course was a year or two previous. Another theme was low mathematic skills due to lack of strong foundational skills from earlier academic experiences or having been "passed along in K-12 mathematics" (p. 73). The instructors identified several factors that hindered developmental mathematic course success, such as family/work responsibilities, effort, and poor attendance. Other themes identified dispositional and situational factors that included study skills, time management, motivation, attitude, confidence, anxiety, performance expectations, and not being prepared for college (p. 74).

This section covered the themes found in the literature review. UDL use in curriculum, course design, and technology in basic skills math provides ways of teaching and learning that could yield better completion rates and success for all students. The exploration of instructors' and students' perceptions of UDL use in higher education provides an understanding of how UDL could work in basic skills math courses, as well as the factors that possibly provide success or barriers to basic skills math completion. The section's final theme addressed the current approaches to postsecondary basic skills

in general and basic skills math in particular. This provides an understanding of what is going on currently in the postsecondary field with basic skills math students.

Summary and Conclusions

The conceptual framework for this dissertation study includes the work of Knowles (1973) and Kolb (1984) as they pertain to the teaching and learning processes of adult learners, and UDL principles as they pertain to the specific approach to basic skills math. Knowles's (1973) theory provided a basis for understanding the principles of adult learning, also called andragogy, as they apply to the experiences of participants in this study. Kolb's (1984) theory provided additional understanding of adult learners in the community college setting through the exploration of experiential learning. These adult learning principles along with the conceptual framework in the principles of UDL are intertwined in this research study with the intention to better understand the adult learning process related to the learning and teaching of basic skills math. Since math can be a challenging aspect of the community college experience, exploring the experiences of instructors in the SULP with a UDL Smartpen in basic skills math curriculum could yield information that will benefit all students.

Three current areas of research in the field were noted that point to a gap in the research literature: (a) UDL curriculum, course design, and technology, (b) student and faculty perceptions of UDL in general, and (c) approaches to postsecondary teaching and learning basic skills, particularly basic skills math. UDL curriculum, course design, and technology were demonstrated as important aspects of learning mathematical concepts for students in community colleges (Gradel & Edson, 2009; Harrison, 2006). Additional

studies (Jackson et al., 2009; Morra & Reynolds, 2009) covered how UDL was incorporated into the curriculum at the community college level, as well as how the use of technology could support UDL principles and have an effect on students' learning. Cafarella (2014) explored best practices from math instructors' perspectives indicating that some of the methods that worked with developmental, or basic skills math students included collaborative learning, organization and structure within the math curriculum, persistent communication between instructor and students, and frequent low-stakes assessments (p. 48). Additional practices such as accelerated learning worked (Raines, 2012), but with a limited type of developmental population, such as with those who had a good number sense, time management skills, good organizational skills, and successful experiences with developmental math prior to the current course. These practices can be built into course design and curriculum.

Second, student and faculty perceptions of UDL in other experiences have shown positive perceptions in learning mathematical concepts in K-12 education (Kortering et al., 2005; Schelly et all, 2011; Woodson-Day et al., 2011). These types of studies provided valuable information and a frame of reference for this dissertation's research, as student and faculty perceptions often yield their own personal truths. What people perceive can be real for them, and listening to those perceptions can help form understanding about how adult learners could be successful in basic skills math. UDL has limited research at the higher education level (Rose & Meyer, 2002). For example, little is known about the use of UDL from the adult learner or community college students' perspective. Would research about the instructors' experiences suggest using a

combination of adult and experiential learning with UDL principles provide meaningful learning basic skills math concepts?

Finally, approaches to teaching basic skills and basic skills math to postsecondary students with and without learning disabilities demonstrated some success (ASCCC, 2010; Arnett & Van Horn, 2009; Cafarella, 2014; Heiman & Shemesh, 2012; Offenstein & Shulock, 2010; Raines, 2012; Stern, 2012; Trenholm, 2009; Wenner et al., 2011; Zeintek et al., 2014). Incorporating the use of assistive technology for students with learning disabilities and students without learning disabilities has been shown to be beneficial as the use of assistive technology provided confidence as well as the ability to check and support completed work (Heiman & Shemesh, 2012).

Other approaches researched involved general use of computers in basic skills math (Stern, 2012; Trenholm, 2009; Wenner et al., 2011), learning communities linking math and science coursework (Arnett & Van Horn, 2009), and intensive short-term mathematical learning before the actual math class begins (Raines, 2012). The faculty perspective related to what factors contributed to placement and hindered success in developmental or basic skills math classes suggested information that could be used for policy and practice (Zientek et al., 2014). Strategies geared towards equity-mindedness, cultural competence, and UDL were identified by the Academic Senate of the California Community Colleges (ASCCC, 2010) that can be infused and implemented in current basic skills math programs of CCCs.

Studies on UDL and the use of technology that support UDL principles were not prevalent in the higher education system, especially in community colleges. There appear

to be few studies on implementing UDL in basic skills math classes at the community college level (Rose & Dalton, 2009; Rose et al., 2006; Rose & Meyer, 2002) and no research related to the instructors' experiences in a Smartpen pilot project that used UDL in basic skills math classes at the community colleges were represented in this study. This lack of research demonstrates a significant gap in the field of study. My study is intended to be a follow-up to the 2011-2012 pilot project to add to the body of research and consider the connection between UDL and community college curriculum, specifically basic skills math. It will also provide a needed perspective of instructors who have incorporated UDL technology into their teaching as a means for helping basic skills math students and adult learning andragogy.

Chapter 3: Research Method

The pathway for completing an associate's degree for many CCC students who need to take basic skills math classes is a long and unsuccessful journey (Illowsky, 2008). UDL can serve as a method that helps adult learners complete basic skills math and the subsequent math courses needed to achieve their academic goals. This exploratory interview research study was designed as a follow-up with instructors who participated in an earlier math pilot project using UDL in several CCCs in California. This chapter outlines the qualitative approach used to examine, interpret, and understand the experiences of four instructors using the UDL approach and a Smartpen in teaching basic skills math. Included are the research design and rationale for the study, the role of the researcher, methodological approach, issues of trustworthiness, and finally, a summary of the chapter.

Research Design and Rationale

The research questions I asked in this study were:

1. What are the professional development and teaching experiences of community college basic skills math instructors who use UDL and Smartpens in their basic skills math curriculums?
2. In what ways has the experience of using UDL and Smartpens informed community college basic skills math instructors' current teaching approach?

The central phenomena around which the exploration revolved around were community college basic math skills instructors' experiences with UDL principles and a Smartpen. This experience began in 2011-2012 with a pilot project (SULP, 2012)

designed to generate a new approach to teaching basic skills math to primarily adult learners in the CCC system. My approach taken to address these research questions included interviews with phenomenological and narrative aspects to provide an understanding of the instructors' experiences teaching basic skills math with UDL and its technology tool.

A narrative inquiry is "the study of experience understood narratively" (Clandinim & Huber, 2010, p. 436). It essentially is a way to study, think, and understand experiences through dimensions of time, place and social interaction, a collaboration of sorts between the researcher and participants (Clandinim & Huber, 2010, p. 437). This hybrid of exploring experiences with phenomenological and narrative aspects will allow examination and deeper understanding of the limited number of instructors whose use of UDL and a Smartpen, including their perspectives from the pilot project that has occurred over time. This allowed for a natural flow of information and no expectations of preset themes.

The questions formed for the individual interviews were designed to be open to the participants' perspectives, whatever they might have been. This exploratory interview approach with phenomenological and narrative aspects was chosen because teaching basic skills math using UDL in the 2011-2012 pilot project was an event, a catalyst that propelled its continued use of the pen by the participants in this study. The narrative inquiry allowed for the study of the experience of this phenomenon as a story. A quantitative approach was not considered because the teaching methodology had not been

developed and sustained across multiple institutions to involve measurement of learning improvements.

Role of the Researcher

This exploratory interview study with phenomenological and narrative aspects focused on the interviews with four math instructors from the original pilot project's college or who currently use a Smartpen. My role in this study was as a research interviewer and not as a passive observer. I conducted the interviews, transcribed the recordings, and analyzed the responses. Although my college participated in the study, I was not an instructor participant. Because I am the only individual who collected and analyzed data for this study, the potential for researcher bias existed. I also used a Smartpen in my own doctoral studies and in my work, and believed prior to this study that it had helped me in my learning as well as, anecdotally, some of my students. These positive experiences could have skewed my analysis and in order to deal with this potential bias, I used strategies such as member checking and peer review to limit potential bias and maintain the trustworthiness of the study.

Methodology

In this methodology section, I cover the research design of this dissertation study by identifying the population for the study, how the participants were determined and then selected, procedures for recruiting participants, data collection, and the instrument used for data collection. Finally, I cover the data analysis plan and ethical procedures.

Participant Selection

There were 31 math instructors teaching in the original 2011-2012 pilot project across CCC. After that academic year however, the SULP program no longer officially supported the project in all 19 colleges due to the technology changes of the pen that no longer could provide the web-based support for instructors in more than one of the colleges. Consequently, it was unknown how many of the instructors continued to use UDL and the pen in some format. However, the project manager at the remaining college that originated the math pilot project continued to extend the work of the pilot and provided access to participants for possible selection in this project. The project manager's college had three instructors currently teaching math, using UDL and a Smartpen; two of them participated in the original pilot project, one was recruited later. My original intent was to recruit these three instructors to explore their experiences using UDL's approach with a Smartpen in teaching basic skills math.

My goal was, therefore, to have a minimum of three (a criterion for narrative approach), if they are available and agree to participate. In the event that these three were not available, I would attempt to recruit three other basic skills math instructors who either participated in the pilot project or were currently using UDL and a Smartpen as a tool in teaching their CCC basic skills math classes. If additional instructors were available and interested in participating, then I would then extend the participant pool based on the project manager's network of basic skills math instructors using UDL and a Smartpen. The project manager gave three instructors' names as those who either participated in the original pilot project or are currently using a Smartpen in their

teaching. Two of three instructors agreed to participate. Two more names were selected, one because of their participation in the earlier pilot project and the other was supplied by one of the instructors who was interviewed.

Miles, Huberman, and Saldana (2013) stated "qualitative researchers work with small samples of people, nested in their context and studied in-depth... [and]… qualitative samples tend to be purposive rather than random" (p. 31). The sampling strategy used in this study was criterion sampling. Creswell (2007) indicated that criterion sampling can be used when all participants have experienced the same phenomenon (p.120). Patton (2002) suggested that all cases studied meet "some predetermined criterion of importance" (p. 238) as a strategy for quality assurance efforts. The intent for this exploratory interview approach using phenomenological and narrative aspects was to delve into a particular shared experience to gain understanding of the essence, or meaning, of the phenomenon from the perspective of the phenomenon's participants. This required a smaller, manageable number of study participants to individually interview, per Moustakas's (1994) guidelines.

The narrative inquiry has three dimensions that are unique to this methodology. The use of temporality, sociality, and place dimensions provides a conceptual framework for studying the "relational composition of people's lived experiences [and the imagining of the] future possibilities of these lives" (Clandinim & Huber, 2010, p. 436). The 2011-2012 pilot project (SULP, 2012) provided an initial point in time of the start of the experience of community college instructors in using UDL and a Smartpen approach to teaching basic skills math. Since there were a limited number of original participants

available to select, the number of expected participants for the sample was a minimum of three, including those currently available and who continued the experience of the original UDL and Smartpen teaching approach.

The project manager for the program had agreed to act as a liaison in identifying the participants. Following Walden University IRB approval (#09-03-15-0230431) expiration date September 2, 2016, an invitation to participate with a description of the study, my contact information, along with an informed consent with details of the purpose, benefits, and risks of the study were sent to the instructors who fit the criterion as identified for me by the project manager. The initial attempt to recruit the three instructors at the college was successful with two of the three instructors. The third was on sabbatical and did not respond to the email invitations. I was able to identify two additional potential participants through the one of the participants and project manager. Both were willing to participate.

Saturation was not expected due to the sample size was small. However, saturation in data analysis was possible as the categories and themes developed were explored to the point of saturation (Creswell, 2007; Moustakas, 1994). I came to a point where no more information could be found and I had exhausted the information to the point of saturation.

Instrumentation

I developed the interview protocol used as my data collection with the supervision of my committee instrument (see Appendix). The questions explored the participants' experience in reference to their past and present teaching in math, their prior experiences

with UDL and technology use in teaching, and comparisons of past experiences with the phenomenon experience of the math pilot project as well as subsequent teaching since the pilot project. All questions were developed for the interview protocol to ensure that the participants' experiences were thoroughly explored and data collection was exhausted. Moustakas (1994) suggested informal interviewing, open-ended questions, and topical-guided interviews as options in conducting a phenomenological research interview for obtaining descriptions of the experience (p. 181). Topical-guided interviews are used to help generate sufficient meaning and depth from the interview and help facilitate rich, vital, and substantive descriptions of the experience (p. 116). The interview protocol for this study used these suggestions in open-ended questions and specific topics related to the experience.

Validity refers to the accuracy or authenticity of the research and the findings (Creswell, 2007). There are difference points of establishing validity within qualitative research such as in data analysis, which will be described in a later section. Content validity is in reference to making sure the interview protocols are accurately collecting credible and authentic data for analysis. The questions in the interview protocol were tailored based on the current research in UDL and a Smartpen in the literature review to gather information about specific aspects of the participants' experiences. Additionally, questions were peer-reviewed by my committee and were approved by IRB prior to use.

Procedures of Recruitment, Participation, and Data Collection

I worked with the pilot project manager to obtain the names and contact information for the instructors to serve as study participants. All interviews took place

following IRB approval. I contacted the instructors via email with the invitation to participate to inquire about their interest in participating in the study. Once an instructor agreed to participate I arranged to conduct phone interviews at a date and time of their convenience. I conducted two interviews with each participant over a one-month period at the mutually agreed upon time. I digitally audio recorded all interviews and transcribed the audio recordings verbatim by using a laptop and word processing software. The initial interviews lasted 45-60 minutes. Each participant was asked to respond verbally to questions related to their experience teaching in the basic skills math pilot project and/or with a Smartpen. Background information was obtained through the interview and rapport building process. A second follow-up interview of 30-45 minutes covered questions related to their challenges, changes, or additional UDL strategies implemented in their basic skills math courses in the past academic year.

At the conclusion of both interviews, participants were thanked for participating in the study. They received a $25.00 Amazon gift card for their participation after conclusion of their participation. Participants were reminded of the confidentiality of their identity through the use of aliases. I emailed their transcripts to them to review the data for member checking and provide any additional thoughts.

Data Analysis Plan

All data collected through the interviews were transcribed verbatim and used in the analysis. The transcripts were coded and then reduced or developed into themes. Moustakas' (1994) analysis method includes first developing a list of significant statements from the transcripts about the participants' experiences in the pilot project. I

listed the significant statements and then grouped them into larger units of information, also called themes. A description of "what happened" for the participants while in the pilot project providing some verbatim statements to support the description, also known as textual description (p. 47). Moustakas (1994) stated the textual description would include the participants' "thoughts, feelings, examples, ideas, [and] situations that portray what comprises an experience" (p. 47). I wrote a description of what Moustakas' identified as the "structural description of an experience, the underlying and precipitating factors that account for what is being experienced" (p. 98). The final data analysis and representation was a composite description of the experiences including the textural and structural descriptions, developing the essence or true meaning of the phenomenon experienced (Creswell, 2007). Moustakas' asked the question, "How did the experience of the phenomenon come to be what it is?" (p. 98). I used the dimensions of temporality, sociality, and place to help tell the story of the participants' experiences teaching basic skills math with UDL and its technology. The experiences were then analyzed through the lens of adult learning theory and experiential learning theory to develop meaning of the factors involved in basic skills math instruction with UDL and its technology tool.

Issues of Trustworthiness

Credibility is *truth value* and represents the authenticity or internal validity of the study (Miles, Huberman, & Saldana, 2013, p. 312). I used context-rich, meaningful, and thick descriptions in this qualitative study. The data presented was linked to categories of theories, and I used member checking with the participants of my data analysis to check my interpretation of their experiences (Miles et al., 2013). Triangulation is the process of

using multiple data sources, methods, and theoretical schemes as a form of validation (Creswell, 2007, p. 204). I used the pilot project information and the theories and conceptual framework to corroborate the themes or perspectives identified.

Reliability or dependability is checking "whether the process of the study is consistent, reasonably stable over time and across researchers and methods" (Miles et al., 2013). Strategies I used to enhance reliability in this study were making sure the interview questions were clear and features of the study design were aligned with the questions; explicitly describing my role and status as the researcher, and making data quality checks for researcher bias (Miles et al., 2013).

Transferability, or external validity, is whether the conclusions of the study can be used in other contexts or be generalized (Miles et al., 2013). In order to enhance the transferability, I reported the limitations on sample selection and its ability to generalize to other settings and contexts. I provided rich, thick description of the experiences so the reader can assess the "potential transferability and appropriateness for their own settings" (Miles et al., 2013, p. 314). I also followed Miles et al.'s suggestions on explicitly stating any theories and their transferability from the study as well as describing the processes and outcomes in the conclusions that were applicable in comparable settings (p. 314). I also debriefed with my committee as an external check on the research process to help ensure that I, as the researcher, had done what I need to do to represent the phenomenon and its essence in an appropriate way.

Confirmability, or objectivity, as noted by Miles et al. (2013), is that there is a relative neutrality and reasonable freedom from unacknowledged researcher biases-or

minimally, explicitness about the biases that do exist (p. 311). In order to increase confirmability of the research, the study's methods and procedures were described explicitly and in detail, as well as the actual sequence of how data was collected, processed and analyzed. Additionally, I was self-aware and reflective as possible about my own personal assumptions and biases related to any aspect of the study and how these assumptions and biases influenced data analysis.

Ethical Procedures

I obtained from each participant the signed or agreed to participants' consent form that included a description of the study and its central purpose as well as procedures that were used to collect data (interviews). Additional statements on the informed consent included protecting confidentiality of the participants, any known risks to the participants in the study, expected benefits to the participants in the study and their right to voluntarily withdraw from the study at any time. The use of four instructors who teach at the host college allowed a recruitment number that was manageable for data collection.

Interviews were anonymously reported through the use of aliases for both participants and colleges to protect confidentiality. All confidential data such as interview notes, transcriptions and any other personal identifying information will be protected with aliases for personal reference and settings. Data was stored digitally and in written format on a password protected laptop and external computer hard drive and is only accessible to this researcher. All data will be destroyed five years after the completion and acceptance of this dissertation.

Summary

This chapter reviewed the methodology for this dissertation study. This study's intent was to seek a deeper understanding of the instructors' personal and shared experiences from the beginning of the 2011-2012 pilot project to the present in learning and using UDL and a Smartpen in the teaching processes. In this chapter I discussed the participant recruitment process, as well as data collection and analysis processes. The data collection instrument used was a researcher-developed interview protocol based on questions related to UDL and technology use in teaching math, prior experiences with math and the perceptions of math teaching. I concluded the chapter with how I established validity, trustworthiness, and ethical procedures in the study to assure accuracy and credibility of the study. The next chapter reports the results of the study.

Chapter 4: Results

Chapter 4 presents the findings of this exploratory interview study that examined phenomenological and narrative aspects of the community college basic skills math instructors who use UDL and Smartpens, and how these experiences informed their current teaching practices. In this chapter, I describe the phenomenological event that these instructors participated in or that served as a catalyst for their use of a Smartpen in their teaching. It includes a discussion of participant demographics, data collection, data analysis, evidence of trustworthiness, study results, and a summary.

Data Collection

This study was designed to explore a phenomenological event that took place the 2011-2012 academic year in 19 CCCs. This study addressed the question as to whether a UDL approach worked as applied to the community college population basic skills math courses from the perspective of the instructors' experiences. Basic skills math courses in community colleges tend to be a form of gatekeeping to degree completion for many students with diverse backgrounds, skills, and ages (Illowsky, 2008). UDL approaches in the K-12 system have been effectively applied to populations of students with learning disabilities (Rose et al., 2006). The research questions for this study addressed this UDL approach that was used in the community college system:

1. What are the professional development and teaching experiences of community college basic skills math instructors who use UDL and Smartpens in their basic skills math curriculums?

2. In what ways has the experience of using UDL and Smartpens informed community college basic skills math instructors' current teaching approach?

I developed the interview questions using a conceptual framework that combined Knowles' (2005) adult learning theory, Kolb's (1984) experiential learning theory, and UDL. These provided the lenses with which to examine and add meaningful perspective to this phenomenological narrative study.

Participants

There were 31 original participants from the original 2011-2012 Smartpen pilot project from 19 different community colleges who had taught at least one math course with a Smartpen at their college. The Smartpen pilot project manager at the host college continued to use the UDL Smartpen approach after the 2011-2012 pilot project ended. The project manager provided access to three math instructors who were still using a Smartpen in their teaching. Two of these three math instructors were in the original 2011-2012 pilot project and agreed to participate in this research study. The third math instructor was hired at the host college after the original 2011-2012 pilot project ended and had been teaching most of the college's basic skills math classes with a Smartpen. These three instructors were selected because they worked at the host college and were known to the 2011-2012 pilot project manager as instructors who taught math with a Smartpen.

The other community college instructors from the original project were not all known to the Smartpen pilot project manager since they were recruited for the Smartpen pilot project through peers at these colleges, As a result, there was no record of who the

other instructors were who had participated in the 2011-2012 pilot project. Consequently, they could not be recruited for this research study. All three instructors from the host college who had participated in the pilot project were invited to take part in this dissertation study and sent a consent form. Two of the three participants who were initially invited agreed to take part, but the third was on sabbatical and did not respond to the invitation. Two additional participants were selected through the use of snowball sampling.

All four instructors who participated in the study were teaching basic skills math and college-level math courses at a CCC campus at the time of the data collection. Three were full-time faculty, tenure-track, one instructor was a part-time faculty member who had taught at the host college. Two of the participants were part of the original event; two taught with a Smartpen with the original event serving as the catalyst. All four instructors had taught basic skills and college level math courses for a minimum of two years before their participation in this study.

I sent each recruited instructor an invitation email along with the informed consent form. As the instructors responded, I set up appointments for the initial semistructured interview. The second interview time was scheduled after the first interview.

Interviews

Using phone numbers provided by each of the four participants, I conducted audio-recorded phone interviews during evening hours at a mutually agreed upon time. The instructors were at their chosen location for their interviews. Each of the study

participants was asked all of the questions on the interview protocols unless they had answered a question in the course of their answering the previous questions. Follow-up questions were asked when the participants' answers opened to another topic, to elicit greater detail, or for clarification purposes. Each participant's two interviews occurred on different days. The second interview allowed for the participant to reflect on the first interview and add any additional information to both interviews and the questions. All interviews were digitally recorded using a Sony digital recorder and a Smartpen as back up; the first and second interviews were each an average of 45 minutes in duration.

Data Analysis

The first step in data organization and analysis was to transcribe the first and second interviews for each participant. I transcribed each interview recording. Transcripts were sent to each participant for member checking and a chance for additional thoughts and elaborations. Using Saldana's (2013) approach to coding, I generated a spreadsheet to use with each transcript for the first cycle of coding where I used *verbatim coding*. Then, I created a table using the research questions and participants' verbatim coding. The codes were then placed in the table according to their relationship to the research questions and color-coded to highlight similar patterns. For example, when participants' described similar experiences and decisions that resulted in them becoming a community college math instructor, they were subcoded as *Inspiration/Influence*, with the overall theme code as *Instructor Preparation.* Part of the response to the question about how one became involved in teaching with a Smartpen included information about how many part-

timers and full-timers were in the department and trying to get a grant for pens for all of the instructors was left uncolored and not included in the emerging themes.

Four major themes emerged from the study with 12 subthemes identified. The themes were *instructor preparation*, *technology use* and *savvy*, *student needs*, *instructor flexibility* and *adaptability*. Twelve subthemes were identified: The first four--*when young*, *inspiration* and *influences*, *math skill*, *chose community college*—were related to *instructor preparation.* The subthemes *more training*, *technical difficulties*, *instructor technology savvy*, and *student technology savvy* were a part of the *technology use* and *savvy* theme. The subthemes *awareness of student needs* and *different modalities* were a part of the *student needs* theme. The subthemes *instructor feelings* and *concerns* and *instructor flexibility* were a part of the *instructor flexibility* and *adaptability* theme. Table 1 provides a visual representation of the themes and subthemes.

Table 1

Themes and Subthemes

Themes	Instructor Preparation	Technology Use and Savvy	Student Needs	Instructor Flexibility and Adaptability
Subthemes	When young	More Training	Awareness of student needs	Instructor feelings
Subthemes	Inspiration and influences	Technical Difficulties	Different modalities	Instructor Flexibility
Subthemes	Math Skill	Instructor Technology Savvy		
Subthemes	Chose Community College	Student Technology Savvy		

Evidence of Trustworthiness

The semistructured interviews with questions developed to gather data to respond to the research questions and the conceptual framework allowed for a comprehensive understanding of the experiences of the participants in the study. I used the two separate interviews, member checking, and conceptual framework to support the themes that I identified.

Credibility

Credibility is a form of authenticating the study also known as establishing internal validity using context-rich, meaningful, and thick descriptions (Miles et al., 2013). Member checking was used to ensure that the meaning of the interview responses were appropriate and captured the essences of the participants' experiences. The conceptual framework including Knowles's (2005) adult learning theory, Kolb's experiential learning theory was used to corroborate the themes established.

Reliability

Reliability, or dependability, was established through the use of consistent interview questions asked of the participants and the questions were aligned with the study design and intent (Miles et al., 2013). The interview questions and protocol were reviewed by my committee and edited based on their suggestions. The questions were aligned to the overall research questions, Knowles's (2005) adult learning theory, Kolb's (1984) experiential learning theory, and UDL (2014) conceptual framework. I was the only person who conducted all the interviews and transcribed all the data.

Transferability

Transferability, or external validity, is noted with a consideration of the limitations in terms of sample selection. This created limited ability to be generalized to other settings and contexts beyond instructors who use the Smartpen in community college basic skills math instruction. Based on the thick description of the instructors' experiences, though, it is possible to suggest transferability potential and appropriateness that might apply to other similar settings.

Confirmability

Confirmability, or objectivity, is noted through explicit examination of researcher bias. I designed the study and conducted the interviews. I also transcribed the interviews and analyzed the data. Although I had knowledge of the initial Smartpen project (the phenomenological event) prior to conducting this study, my interest in the project and the use of UDL stemmed from my own use of a Smartpen in my work and my personal experiences but these were not related to teaching basic skills math at community college. My intent in the study was to expand the knowledge and understanding of UDL and its technology tool in higher education, specifically the community college. No studies were found that had focused on its use in this setting, with this specific population, or with this specific content. The open-ended interview questions were designed to explore the research questions with the perspective lens of the UDL conceptual framework, Knowles's (2005) adult learning theory and Kolb's (1984) experiential learning theory.

Each participant was asked all of the interview questions on both interview protocols in two separate sessions. Follow-up questions were asked of all participants in

order to clarify responses or elicit more specific information. Only one of the participants was aware of my professional experience with a Smartpen. In my professional work, a Smartpen is a tool that I endorse for regular use with my students. None were aware of my personal experiences with UDL and a Smartpen. I use a Smartpen in my own learning, often taking it to conferences and trainings because of my learning preferences. Researcher bias was reduced by my adherence to the interview protocols and my perceived neutrality towards a Smartpen by the participants.

Results

Four community college basic skills math instructors participated in the study; two men and two women who have taught with a Smartpen in one or more of their basic skills math courses. One female and one male instructor were a part of the original Smartpen project. The other female and male instructor used a Smartpen in their teaching after the Smartpen project was completed. Pseudonyms are used for all four participants. Four major themes emerged from the study with 12 subthemes identified. The themes that emerged in response to research question 1 were *instructor preparation*, *technology use* and *savvy.* The themes that emerged in response to research question 2 were *student needs, instructor flexibility* and *adaptability.* There was overlap of the *technology use* and *savvy* themes with research question 2. Twelve subthemes were identified.

Research Question 1: Professional Development and Teaching Experiences

In this section I discuss the themes and subthemes as they relate to the first research question: what were the professional development and teaching experiences of community college basic skills math instructors who use UDL and its technology tool, a

Smartpen, in their basic skills math curriculum in the California Community College system? I identified the themes of *instructor preparation* and *technology use* and *savvy* (see Table 1). The results in terms of the subthemes related to each theme are discussed next.

Instructor preparation. The theme that emerged from the questions regarding instructor preparation indicated that all of the four participants were inspired to teach by others, usually teachers who provided motivation and excitement towards teaching and math. The subthemes, *when young, inspiration* and *influence, good in math,* and *chose community college*, were all identified in this theme of *instructor preparation*. Sally described how her skill in doing math and the support she received from her teachers influenced her experience with math and learning when she was young in the K-12 educational system. She talked about how she was always encouraged by her teachers, and she was good with math and did well in math because of the encouragement of her teachers.

Another participant, Cory described a similar experience with a math teacher who motivated the students through positive reinforcement:

> Actually in the third grade, I had a teacher who was an amazing math teacher, and she would give us math packets... First would get ...a prize, and that was really motivating to me, and.... I was constantly trying to be that one (laughs)...and every since then I kind of wanted to be a math teacher....

Jamie indicated that he had "always wanted to teach," having been inspired by family members who were teachers:

> I pretty much always wanted to teach, exactly what I wanted to teach I kind of changed over the years...my mother is a teacher...she's taught everything from kindergarten up through high school... my grandparents-both of her parents were teachers....my grandfather [paternal] was a community college instructor, so education has been a big part of my life and so in some sense it was a natural thing for me to be drawn to [teaching]...and like I mentioned, I really do enjoy it...

Jamie also recalled a grade school teacher, who served as an inspiration:

> I remember very distinctly in fifth grade, I wanted to be a fifth grade teacher because my fifth grade teacher was that awesome.... but I think by the time.... it was some time in either junior high or high school where I was really drawn more to the math, where it was like, 'hey, this is really cool' and that's when the decision came bout...I really wanted to be teaching math specifically.....

As noted, one of Jamie's formative, positive experiences with math happened while he was young in the K-12 educational system. Pat indicated he was influenced in high school through the help and support he received from his instructor:

> I think it started when I was in high school, I had this math teacher who recognized my talent, and it was a challenging class for me because it was an honors math class-Algebra II- and she actually really recognized my needs as a student...she saw that I was struggling, so she would put me in the front of the class and give me additional help outside of class or after class. So that really helped me just connect more with math and actually see myself through her...

> ‘What would I do if I was a math teacher?’.... I was always good in math, but since she helped me....I think I have been just a lot more passionate about it...

All of these participants also found further inspiration later on which helped them make the decision to become community college math instructors. The subtheme of *chose community college* was reflected in their responses. Two of them made the decision while in college pursuing other majors. Two of them had experiences teaching within the K-12 system prior to their transition to community college instruction. Although these pathways may have been slightly different, their decision for teaching at the community college level was influenced by their pathways, as Sally indicated:

> I think that when I got really inspired is when I went to college... when I was in community college and I had a calculus instructor, the most ‘awesomest’ teacher I could have had for calculus... at that point, that’s when I decided to become a math teacher, not only a math teacher, but a community college math teacher....

Cory reported similar inspiration:

> I was a biology major and my math instructor in college asked me why I was not a math major because I was acing [all the work], you know, getting all the extra credit right, highest score in the class and so on.... I told him I was having pressure from my parents to be....going into medicine, and he said, ‘just tell them you can get into medical school being a math major (laughs), so I switched my major to math, and you know.. everything kind of fell in line after that..... I kind of just decided I wanted to work with minorities, and I wanted to work in developmental math courses, and I wanted to be in community colleges to

> accomplish those goals....it was such the contrast from where I grew up to where I landed (in college) and the contrast really shocked me.... and I just felt like that's where I would make the most difference... sort of like a social justice move for me....

College seemed to be the place where these instructors grew in the desire to teach at the community college level. Pat said:

> In college, I started tutoring in math with my girlfriend at the time, and I became a math tutor, and then I just kept taking math classes....I changed my major to math my second year in college...then I actually spent a summer...I took a community college math class-calculus III....I just really liked the format of it, I liked how it just felt different than a university....I work better with students who are just learning math or having a tough time in math....I could kind of see myself in the instructor's shoes in community college...

Preparation for teaching while in college influenced Jamie towards community college:

> As I've grown, I wanted to teach increasingly older students...I did as an undergraduate prepare for teaching high school students and I though I was going to be teaching math to high school students but then when I got to student teaching...I kind of decided 'well maybe high school students might not be the best for me'.... what I was realizing in terms of why I decided to teach at the community college level was the degree to which baby-sitting was the role in the high school classroom.... and I really have a passion for the teaching aspect...so I

> wanted to get in where the real teaching was done...having students who were there not on the basis of 'well you have to be here because it's the law,' but where community college students are choosing to be there....

The path to community college math instruction was similar but not all the same for all the participants. A passion for math began in early stages of education, sometime during the K-12 education years. Positive math role models emerged during this time to help inspire and create positive associations to math. Their math skills were noted and supported by these positive role models. The decision to teach at the community college stemmed from the inspiration and desire to connect teaching, math and older students.

Teaching experiences. The second aspect of the first research question related to the teaching experiences the participants had in adopting the technological approach to teaching basic skills math. The subthemes identified with this part of the first research question were *more training* and *technical difficulties*. The other two subthemes of *instructor technology savvy* and *student technology savvy* that emerged from the *technology use* and *savvy* theme will be discussed later in the results under the second research question.

Each of the participants taught basic skills math courses with a Smartpen. Consistently throughout the interviews, all of the participants indicated numerous times the need for adequate training and support when teaching with a Smartpen. Of the four participants, two were in the original Smartpen project. The other two were not employed at the host college at the time of the original Smartpen project. They joined the host

college a few years after the Smartpen project and were introduced to the pen by the Smartpen project manager.

One of the original participants who worked at one of the 19 colleges in the pilot project just recently incorporated the pen back into his teaching after ceasing to use the pen after the pilot project. This participant, Pat, had reported that during the pilot project, there was considerable trouble with the pen and getting it to work with recording and uploading to the shared site. He did not receive a lot of training or support to get it to function for the class. He did not continue using the pen after that semester. Pat resumed using a Smartpen a couple years later when he moved to a different community college where Smartpens were a tool used in many of the math classes. The community college he moved to had not participated in the original 2011-2012 Smartpen pilot project.

The final participant who used the pen after the pilot project does not currently use the pen in teaching. Jamie used the pen, originally, in his class to help a student with a disability. The Learning Disabilities (LD) specialist had issued it to Jamie as an accommodation for the student. One of the drawbacks was that using the pen in class seemed to discourage classroom attendance, not only by the student with a disability, but other students as well. Another issue Jamie had was the lack of communication and support by the company when the pencasts could not be uploaded to the shared site because of technical issues.

The participants all described their first introduction and training with the pen, which illustrated the need for *more training* and the type of *technical difficulties* they had. Sally, who currently teaches with a Smartpen, described being introduced to the pen:

> I actually was going into the classroom lab to print off something, and the [Smartpen 2011-2012 pilot project manager].... found out that I was a math instructor and [asked] 'Could you teach with this pen?' And I said, 'yeah, what does it do?'..... I was looking for different things to teach with... [the pen company had] a place where you can upload your recordings, so I was like, 'ok, I need to do something'... you can't actually see me, but you can hear me.... so any student from any, say, arithmetic class or algebra class can access them.... [the Smartpen pilot project manager] showed me how it worked, it took about 15 minutes to show me how it works, uploading, and how it's like a Smartpen....if we had problems with it, we just went to [the Smartpen pilot project manager] and [the Smartpen pilot project manager] would either fix it or contact the company.

Pat reported a brief introduction to the pen as well:

> I received an email...asking if I would mind using it [a Smartpen] in my class, and that was for my Elementary Algebra class... and the student [note-taker] takes notes in my class, theoretically those notes would be posted on the course website.... that's how I got involved in the process... from what I remember I was shown how to use the pen... I had to take it home with me for the weekend and I got to experiment. I watched videos [introduction to a Smartpen] online, I did my own training... but I didn't take me long to learn to use it...I just read the manual that came with it... I learned pretty quick how to use it....

Cory described a similar experience in getting started. She had a Smartpen at home that her husband had brought home from a conference and the pen was not being used. She

took the pen to the pilot project manager thinking that it might work in some way for student success:

> [The Smartpen pilot project manager] took it [a Smartpen] and just ran with it...initially just for the practice exams and things like that, where we pencasted at home and then eventually developed a method of pencasting the in-class lectures as well so the student would have those, with the overhead projector.....I don't think I received very much training at all, I kind of just played around with it on my own, figured it out, you know, for pencasting at home....

Jamie, who no longer uses a Smartpen in teaching, described the pen as something that was primarily a student tool:

> I had gone to a workshop on one of our professional development days.... so I had seen the idea of what it does and there were some descriptions during that workshop, kind of a demo... when I went to actually utilize it, it wasn't really so much training as 'this is what, or this is how it works', and 'this is what you need to have the students do'.... I didn't interact with the pen all that much.... it was mainly, I hand off the pen and notebook to a student, who then were taking notes during the class, who then gave me the pen and notebook back... then I was just doing the uploading of all of the files.... so I didn't have a whole lot of training, so to speak... but I tried doing some experimentation with the pen, at home trying to lecture while taking notes in the notebook, but that was an abject failure, I found that I was completely unable to talk to no one in a coherent manner.... When there is no one there, trying to teach to no one, I just couldn't do it.... I misspoke all the

> time and I would write things that I was not saying an not writing the things that I was saying.... so that part of it, I tried to adapt it in that other way, for myself, but it did not work with my strength as an instructor, so its use was primarily a student tool....

In addition to the need for more training and support for the use of the pen, the participants shared their struggles with technical difficulties. All described the difficulties with the Smartpen company, the minimal support, and the pens themselves having glitches and not working. Sally said:

> This is my third pen, the first one stopped downloading and the second just stopped... this is my third pen... so then when we called them [Smartpen] on how to make it work or repair it, they said they are...supporting the URLs that go with the pen, but they are not making new ones [URLs to upload the pen data to], so we have to use the Echo [2nd generation pen] or the Smartpen 3 [4th and newest generation pen]... I think the WiFi [3rd generation pen] situation, it's not really the WiFi we have issues with, it's just that sometimes it will just shut down sometimes.... like I think I'm recording the lecture, but I'm not... halfway through it [the lecture], it's not [recording]… I try to check my pen, make sure it's recording, intermittently and sometimes I will look at it and think, 'wow, it just stopped recording'.... and it doesn't pick up their questions...

Pat also reported difficulties with the uploading to the website:

> The Smartpen notes looked good, it recorded my voice, but we had trouble uploading it to the Smartpen website; there was an issue with the connectivity...I

> remember [the IT technician] was trying his best to get it to upload to the website...I couldn't really do much with it [the pen] and I didn't have the program on my computer...and we couldn't get it to work with the computer, so I really wasn't doing much with it at all, that semester, unfortunately.

Cory described the technical difficulties as creating more of a barrier for students to access:

> I've had a little issue with some of the pencasts...you know, Smartpen has been bought out and there's some issue also posting lectures... now students, instead of just clicking on a link to view the lectures, they now have to actually download the lecture, find where they downloaded it and open it... the more steps you have for students, the more of a barrier it is for them to be able to access it [the material]...it used to be simpler and now it's more complicated for students...yes, so just lately the pen has been really flaky, one pencast and you get home and find out that it didn't pencast, or I'll be in the middle of lecturing and pencasting and find out that, 'oh it stopped, it's not recording' and the screen has stopped working on the pen itself, so I can't tell if it's recording or not....you know, I've replaced the pen like three times in the last year, and it's not getting better right now...the college, the math department in particular, would like to pencast more of our courses but we need to find solutions first, for the issues...

Jamie also reported frustration with the technical difficulties and lack of support from the company:

> The Smartpen site went down for a two-week period and that was very, very bad... so both [the pilot project manager] and I had several conversations with their IT as they were trying to get things up and running, and failing, and students weren't able to access the notes, and people were getting angry with me and me saying, 'I don't have any control over it!'... so that was a headache that I didn't want to have again.

Despite these technical difficulties during the Smartpen pilot project and afterwards, three of the four participant instructors resumed or continued to use the pen in their teaching. These three instructors found ways for the pencasts to be done successfully and shared with their students.

In this section I discussed the themes and subthemes as they relate to the first research question: what were the professional development and teaching experiences of community college basic skills math instructors who use UDL and its technology tool, a Smartpen, in their basic skills math curriculum in the California Community College system? I identified the themes of *instructor preparation* and *technology use and savvy*. With this research question, these instructors' teaching experiences and professional development helped to define the way basic skills math community college instructors found their profession and prepared for their profession. This research question also identified a theme in the use of technology and being savvy in technology in basic skills math teaching.

Research Question 2: Current Teaching Approaches

This next section includes the results for the second research question, in what ways has that experience informed their current teaching approach, by exploring the *instructor flexibility/adaptability* and *student needs* themes (see Table 1). The *technology use and savvy* subthemes of *instructor technology savvy* and *student technology savvy* are also discussed in relationship to this research question.

Technology use and savvy. Three of the four participants who actively use a Smartpen in their teaching described how the pencasts are done in their lessons even with the difficulties with the website and uploading. With technology and its difficulties, there are also other aspects that need to be considered on a personal level- the instructors' and students' levels of technological savvy. The participants noted that with the use of technology, a level of instructor savvy is required, as is a level for student savvy. Sally indicated:

> I'm pretty up on technology so I will try anything....if it's working, I'll use it.. the only time I might not use it [the pen] is because it's not working... I think if they [other instructors] are comfortable with any technology, you have to use the computer, use the Smartpen, be ready to charge it...the other thing is you have to record yourself, some teachers will have students who ask 'can I record you?' and they say 'no', they [the teachers] are just not comfortable being recorded and stuff... you have to have a comfort level of being recorded...[they need to be] comfortable with technology and being recorded...

Pat brought up that part of being tech savvy requires awareness and being prepared for the potential glitches that can come with technology:

> If you are going to be doing the uploading all yourself, I think you have to have some technology background, you have to know how to upload files and save as PDFs and upload to your course management system... that's the hardest part about learning how to use the pen... and another thing is being dynamic. You have to have a back up plan... I had ways for students, if the pen doesn't work, have other ways to get the notes....one difficulty was with the document camera, it was so bright... it actually caused the writing in the notebook to not come out clearly...so you have to kinda know a little bit about the technology behind the pen, because the dot paper has to have a certain amount of light on it... if it's too bright.... it definitely won't show up very well....captioning too is an issue, you wanna make sure anything you post on your course management system is ADA accessible... and so you might have to get a captioning service or find somebody to caption it for you, or get automatic captions whenever that's possible... which are not always reliable...

Cory indicated that the college math department was considering using the pen for lower math levels such as Arithmetic:

> I don't use it in my arithmetic course yet... I've been sort of playing with the idea, because the homework for arithmetic is not online. I've been kind of questioning... different classes have different levels of technical skill, so we worry, the math department .... tends to worry more about the arithmetic students

> and their computer tech-savvyness... and so we haven't been putting the homework online or lectures online, but you know, I have had groups of arithmetic students who would have really benefitted...

Sally also noted that there are students who might not be technologically savvy:

> There's a good amount of students who are not ready for technology because they don't have access to technology.... they are not familiar with the community for that kind of thing... it's not like they own a laptop or iPad, or have a smartphone, or anything like that... there are certain expectation levels that you have for them, but you have to work around, can they do it between Monday through Thursday when the math lab is open because they might not have access to that kind of equipment... it could be that they haven't worked with computers before... or in a long time....you get the returning students, older students, you know, students who don't have that kind of access to things or know technology, so you are teaching that [technology] while you are teaching them how to do math....

Cory also noted that access to technology needed to be easy for students both with logging on and financially:

> When there's too many steps for accessing the pencasts or accessing MyMathLab or accessing whatever, I have students who don't make it through those steps... it's a barrier to them... so logging in for some students for the first time, you know sometimes it takes some students longer to do that single step or registering and logging in... and also students don't always purchase the access code immediately

> for MyMathLab or MathExcel and that can be a barrier too... because they can't get their homework immediately and they will fall behind quickly...

Pat thought other instructors should know that being technologically savvy takes time:

> With technology especially, you definitely want to spend...a semester or a couple weeks at least getting use to technology before you start using it in the classroom...that's important and...you might get resistance from students from technology or new ways of teaching... but I think it's worth it to just stick it through and just show them it's going to help...

Jamie also believed that timing can have a factor in effectively utilizing the pen:

> [I think] really exploring 'how can this be a tool that's going to theoretically help students learn better and theoretically help me teach better' [is important], I did adopt it mid-semester which was really like trial by fire and so I didn't really have time to get up to speed with [it] and figure out some of those techniques to use would really be helpful...

Instructor Flexibility and Adaptability. The *instructor flexibility* and *adaptability* theme was important in projects or programs implementing UDL. As noted, challenges can come up during the planning and implementing of UDL and its technology. These instructors had to be able to make changes in the way they teach when plans or technology did not happen as planned, and they needed to have a willingness to incorporated new techniques and ideas.

This theme also addressed how some of the instructors felt when students were not catching on. Pat talked about how each class has a personality and that some semesters there was a level of frustration because no matter what he tried, it seemed like he could not help them be successful. Jamie expressed frustration when the pencasts were not uploading, when there was a lack of support from the company, and that few of his students seemed to be using the pencasts appropriately in their learning. Jamie felt that the students were using the pencasts as an excuse not to come to class, but he was unsure as to how many actually utilized the pencasts later in lieu of coming to class.

As one of her ways to combat students' lack of *technological savvy* and to help them flourish with the math content, Sally put her students in support groups outside of the classroom. Sally felt that these support groups were helpful in students learning and she adapted in an effort to adjust to all the students' needs by providing varied activities in place and provide various learning opportunities. She felt that the support groups were one of them:

> I have noticed from my students that they really flourish in the class....where they are put into support groups outside of the classroom...the reason they are so successful in basic skills math classes and going all the way up through to the transfer classes, it's because they went through together and stuck together outside of class, they helped each other prepare in the classroom...

Pat has had semesters where adjusting teaching could be a constant. He incorporated different activities in hopes to engage his students. He acknowledged that in using a Smartpen in his teaching made him a better teacher. He indicated that it helped

him be more efficient and provided a way to reflect and evaluate his teaching and to see where he might need to make adjustments. He talked about the importance of being flexible as an instructor:

> I think they [other instructors] should know that note very type of UDL is going to work for them or their class, they might need to see the personality of their class before trying... I mean they might need to try multiple things, different techniques to see what sticks for the classroom, but if it doesn't work the first time....that may not mean that it's never going to work, just kind of having like an idea of it doesn't work the first time, you might just have to change it up a little bit, I might have to adjust my teaching...

In order to address these semesters, Pat attempted different techniques and technologies in his class:

> I use the document camera... I've used the smartboard, projector... a tablet PC...oh I used an iPad in the classroom too... I've shown students different apps they can get and I actually use it for the textbook... I pull up the textbook so if they have a question from the book, I can just pull it up on my iPad... and I can project it so the students can see it... and there's a ton of apps I want to start using on there... I just have to play with them a little bit....

He has also considered changes he would like to make in teaching his basic skills classes to be more student-based learning:

> I'd like to get them [the students] more involved in the learning process and get them, in a way to teach each other... and more project-based learning, and ....to

> introduce more nontraditional techniques, use more of those in my class... like group work, working on the board, having group discussions, like having a more realistic type scenario and just have them in groups talking bout the reality of this mathematical idea and do... maybe a case study or something like that...

Cory also uses varied techniques and methods to help teach math:

> I use the document camera, I use the smartboard, I try to go online during class and on occasion, not regularly, maybe once a month or twice a month, I go online during class and look up some interactive programs to do whatever topic we are covering that day....and have students go up to the board and have them play online games related to the topic that we are covering....the other technologies aren't a representation of my teaching...verses a Smartpen....like when they watch the online videos that are provided by MyMathLab [online homework program] for the book, and then they see my Smartpen pencast, they always seem to prefer my Smartpen pencast... I think because I'm kind of quirky in how I teach (laughs) and it kind of sticks better... it's not as standard, you know, it kind of sticks better... and it's their teacher, the teacher's voice makes a difference I think....

Jamie too demonstrated adaptability and flexibility in his teaching techniques in order to engage his students with math:

> My favorite piece of technology has been the document camera.... for reasons I'm not even completely sure about, students seem to respond to notes with the document camera and presenting material much better than working on the board.... they were also more willing to volunteer to present their work on the

> document camera rather than re-writing their work on the board... and so because I do emphasize the engagement and interaction with students that way, their willingness to participate with the document camera has been... for me, what makes it such a useful tool...

Jamie also discovered that the way he structured his class made a difference in students' learning,

> I have begun putting up agendas for the class to know what to expect for the day...I found that it kind of keeps students not necessarily on task, but I don't need to deal with students closing up their notebooks when I have a half hour of lecture left, just because we finished one section...so by having that on the board, they know exactly what we are supposed to cover today...they know when my expectations that class will finish...I discovered through experience teaching... that giving students very poor grades on their homework, they don't notice that at all, they don't recognize that 'hey, I'm doing really poorly' for some reason... the homework scores 10 out of 25, 13 out of 25, 8 out of 25... they don't register that they are doing poorly... but when they see quizzes with letter grades, they respond to that... they say 'hey, I'm doing poorly, I need to buckle down and start to paying attention', or 'oh hey, I need to go visit him during his office hours'.... or 'maybe I should go to class more often'....it kind of gets their attention in a way that low homework scores just don't and so I now quiz much more frequently.... kind of a more formal assessment of their learning, to give them feedback of

> when they need to be changing what they're doing if they expect to pass the course....

Jamie also brought in activities to teach concepts that are different and varied:

> Using polyhedral dice is the biggest thing of varying instruction that I do with basic skills... anytime that they're going to be doing practice of things, I have them kind of creating their own work, creating their own problems with the dice...simple example, when we are trying to find the least common denominators, I'll pull out my big bucket of dice, 'everyone come grab a die'...some will have a standard six-sided die, or a 12-sided die, so we get a good variation in the type of numbers we are getting... so I will have them partner up and 'roll your die' and I have them roll their die and 'alright, see if you can find the least common denominator', of those two numbers you just rolled.... so with that set of partners, they'll roll their dice a few times and hen I have them switch up their partners... so maybe you had a couple low number dice and things were easier... but now you have someone that picked up the 30-sided die, you're going to need to deal with a bigger number...so I will have them switch up their partners and roll their dice again.

Student Needs. This theme illustrated how the participants used their understanding and *awareness of student needs* and *different modalities* subthemes in their current teaching practices. All of the participants had perceptions of their students and were aware of their needs in learning math. They identified the understanding that these basic skills students were often overcome with anxiety about math, typically from having

poor experiences with trying to learn math, or not having many successes in learning math. Sally had indicated how these students were more open to learning when they trust the instructor. Pat, too, said that an instructor has to approach anxious basic skills math students very carefully, that the instructor cannot teach the way one would teach university-level classes. Jamie also pointed out how basic skills math students are often under or unprepared, lacking appropriate study skills and have a defeated attitude when it comes to math, often from previous poor experiences. Cory's engagement with her students helped her identify when her students need breaks, additional examples and humor. She described herself as "kind of quirky" and found that her engaging style helps lower their fear.

The participants also talked about how important it is to use different learning approaches or modalities. In using activities such as the one Jamie just described brings attention to his awareness of different learning styles or modalities and ways to engage his students. He talked about how accessing the kinesthetic and using that interaction, working physically with an object that can act as a learning stimulus for his students. He felt that his students seemed to respond well to the kinesthetic approach in their learning.

Jamie, who is interested in brain-based learning and metacognition research, was not specifically familiar with adult learning theory or experiential learning theory; however, his interest in brain-based learning and other research has created thinking and ways of focusing his teaching to support aspects of adult learning theory and experiential learning theory:

> What I have found really interesting is...when students identify a learning preference or whatever the researcher is calling it... 'I'm a visual learner' for example... and you then set up an experiment, what it's called is 'pairing', when you match the instruction with what the student identifies as their learning preference... very strangely-at least to me- the pairing method where you are matching those [learning and teaching styles] up does not actually, or at least to this point, has not experimentally demonstrated to improve learning outcomes... instead it's not the pairing that has made the difference...having the variation of instructional methods is better than specifically trying to target that self-identified visual learning channel, and so then that's what really made a difference on the different ways I try to engage all of the different channels... it use to be that I would try to focus and make sure I do that kind of instruction [students' identified learning preference], but based on the research, I may maintain that variation of instructional style...

Cory talked about doing a variety of things to engage students in different modalities:

> I try to utilized different, you know, different learning styles, teaching styles in the classroom... I try to write everything, say everything.... sometimes in an arithmetic course we'll pull out flashcards and look on it that way... or where they're playing games with each other... with the flashcards...I'll try to use online manipulatives...memory techniques... I use humor, my humor style in general is meant to lower their fear....

These instructors utilize any and all techniques that they find that can help them reach and engage their students with learning mathematics. They treat their profession as a type of calling, having a passion for their subject and their sharing of their knowledge to community college students. Using a Smartpen is one of the techniques that three of them have found to be a viable and relevant tool in their pursuit of teaching math. The fourth, although not currently teaching with it, believed it to be a good option for students with correct training and practice prior to its use. Although their perspectives might not be purposefully grounded in UDL or various learning theories, due to their desire and passion, they instinctively gravitated towards and are willing to try techniques that utilize principles of UDL's main principles.

The second research question, in what ways has that experience informed their current teaching approach, defined the *instructor flexibility/adaptability* and *student needs* themes. The *technology use* and *savvy* subthemes of *instructor technology savvy* and *student technology savvy* were also discussed in relationship to this research question. *Instructor flexibility/adaptability* was a theme that demonstrated how the instructors used a variety of techniques, activities, and strategies in their basic skills math teaching. It also showed the willingness of the instructors to use a wide range of technology and ideas in order to reach and engage their students with math. In addressing student needs, the instructors expressed a range of emotions when trying to reach and engage their students who were struggling with basic skills math.

Summary

In Chapter 4, I addressed the two research questions through detailed descriptions and analysis of the data collected. The results were based on the perspectives of the four participants who had used a Smartpen in teaching basic skills math in community college in relationship to the conceptual framework. *Instructor preparation* was one theme noted in the data. All four participants identified that when they were young they were inspired or influenced to teaching. They also indicated that through that inspiration or influence they developed or strengthen their own math skills. Often their inspiration came from math teachers. They saw that influence as related to their reasons for choosing to teach at the community college.

Another theme that emerged in the data was *technology use and savvy*. All the participants could identify their need for more training and their difficulties with using the technology that impacted their teaching with a Smartpen. They also all indicated that importance of technological savvy was required in the instructors' and the students' skillset in order to adequately supplement teaching with the use of the pen.

The third theme noted was *student needs.* This theme included awareness of student needs. Each participant felt that the more in tune and aware of their students' needs they were allowed them to address those needs in a variety of ways by using varied activities, incorporating study skills and support groups, as well as humor and interactive activities. The *student needs* theme also addressed a subtheme of needing to use different modalities. Each participant worked hard to incorporate different learning modalities in the activities that they selected in order to reach a student.

The final theme was *instructor flexibility/adaptability*. Instructor flexibility was illustrated in their willingness to incorporated new ideas and activities. Each participant expressed concerns and frustration for their students' difficulties in grasping material. They all indicated that they worked hard to meet the students' learning and anxiety levels about math in order to find ways to help them succeed. These four themes helped build an understanding of the experiences of these community college basic skills math instructors. Chapter 5 will include a discussion of the findings and how these findings extend the knowledge in the discipline.

Chapter 5: Discussion, Conclusions, and Recommendations

In this dissertation study, I explored the experiences of basic skills math community college instructors teaching with a Smartpen UDL technology tool. This exploratory interview study used phenomenological and narrative approaches to help gain a deeper understanding of the teaching experiences of four basic skills math community college instructors who have used this UDL approach with this population of students. Four themes were noted in the data: *instructor preparation*, *technology use and savvy*, *student needs*, and *instructor flexibility/adaptability*. The subthemes helped identify within the themes more specific considerations. For example, within the *instructor preparation* theme, the subthemes included *when young*, *inspiration* and *influences*, *math skills*, *chose community college.* These helped provide a richer understanding of what was important in the participants' preparation and development in becoming a basic skills math community college instructor.

Similarly, within the *technology use* and *savv*y theme, the subthemes of *more training, technical difficulties, instructor technology savvy, student technology savvy*, were important for the participants' experiences with technology and how it influenced their current teaching practices with basic skills math community college students. The theme, *student needs*, identified the instructors' own *awareness of students needs* as a subtheme, and their perception of the importance of using *different modalities* in teaching. The *instructor flexibility* and *adaptability* theme identified *instructor feelings* and *instructor flexibility* as the subthemes. In this theme, I gained a better understanding of the instructors' experiences through their expression of feelings of concern and

frustration for their students' struggle in learning math and their anxiety about math. It also allowed me to see the instructors' willingness to adapt their techniques and willingness to try different teaching activities and strategies to engage and teach their students.

Interpretation of the Findings

These findings extend knowledge in the discipline, addressing a gap in the literature regarding instructor experiences in using UDL technology at the community college level with basic skills math students. Smith (2012) suggested that there was limited research within the field of higher education on UDL and its use by college instructors. UDL provides college instructors with an opportunity to expand and deliver course material in ways that could meet the needs of diverse learners (Smith, 2012). In the literature review, I examined research about UDL curriculum, course design, and technology use; student and faculty perceptions of UDL techniques being used; and the current teaching approaches to postsecondary math. Several studies using UDL approaches examined assistive and adaptive technology in teaching and learning flexibility (Dolan et al., 2005; Messinger-Willman & Marino, 2010; Morra & Reynolds, 2010; Wissick & Gardner, 2008). Rose et al. (2006) examined UDL implementation in the postsecondary levels of education. These studies laid a foundation for this study's approach, the results of which helped to extend the knowledge in the area of the teaching experiences of basic skills math community college instructors.

The conceptual framework for this study used two theories and UDL principles to address the two research questions:

1. What are the professional development and teaching experiences of community college basic skills math instructors who use UDL and Smartpens in their basic skills math curriculums?
2. In what ways has the experience of using UDL and Smartpens informed community college basic skills math instructors' current teaching approach?

The use of these two theories provided a foundation in the instructors' own learning processes in how they worked to teach basic skills community college students. Knowles's (1973) adult learning theory and Kolb's (1984) experiential learning theory were selected as part of this framework because of their connection to learning.

Knowles's (1973) theory focused on adult learners and their learning process and suggested that adults' motivations and learning process was distinctly different from children's learning. This is why Knowles used the term *andragogy*, referring to the art and science of adult learning, rather than the term *pedagogy*, referring to the art and science of teaching focused on young children. Andragogy focuses on the adult learner as an individual learner and the process of learning is at the center of their education, whereas pedagogy focuses on learning as teacher driven, where learning is teacher-directed and subject-centered (Knowles et al., 2005). The six core principles of andragogy are: (a) need to know, (b) learner self-concept, (c) learner's experience, (d) readiness to learn, (e) orientation to learning, and (f) motivation to learn (Knowles et al., 2005, p. 1410.

Knowles's (1973) first principle, need to know, states that an adult learner has to see how the learning is relevant in their life at the time they need it. The sixth principle of

motivation to learn was also seen in these experiences. These teaching experiences of these participants in utilizing the Smartpen illustrate the first and sixth principles of andragogy and abstract conceptualization.

Jamie reported he was working with a student who had a disability and he was struggling to find ways to accommodate the student's learning needs. The Smartpen pilot project manager had suggested he try a Smartpen for a note-taking accommodation. Jamie's desire to help the student learn math connected relevancy to learning about the pen and how it could potentially help this student. Learning about it satisfied a relevant need that Jamie had and motivated him to learn about it and try it.

Pat's experience was similar in that his new college's math department used the pen and other technology regularly in their teaching. When Pat had his first experience with the pen during the pilot project, there were struggles with the pen uploading and being used and he did not pursue avenues to continue use of the pen. When he moved to a different college and the pen was an actively used tool in his department, he found relevancy in learning how to use it and work it into his teaching. He was not essentially motivated during the Smartpen pilot project to learn and do more with the pen, as he seemed to be addressing his students' learning needs at the time, and no other math instructor at his college was using the pen at the time.

Sally who was introduced to the pen by the Smartpen pilot project manager had been looking for different tools and strategies to teach with. When introduced to the pen, she was at a point in wanting to increase her strategies in teaching math and reaching

students. Sally was also motivated to learn about the pen by her desire to increase her teaching strategies for her students.

Cory was also learning about the pen for ways to incorporate it to address her students' learning. She took the time to play around with the pen to figure out other uses, such as prepencasting lecture notes at home and using it for online office hours. She questioned the college IT people about how to incorporate it in class and learned enough information about the pen through these methods to find ways to use it that worked for her and her students.

These strategies addressed not only the first principle and sixth principle in andragogy, but also Kolb's (1973) abstract conceptualization learning style. Abstract conceptualization, or learn by thinking, was illustrated by the thinking and analysis about how to incorporate the pen into their own teaching basic skills math with their students. The instructors gathered information and had training to think about the different options in how they might be able to use the pen in their teaching basic skills math.

The learner's self-concept, andragogy's second core principle (Knowles et al., 2005) is about the adult learner's autonomy, awareness and willingness to be responsible for their own needs and choices, and being seen and treated by others as capable of self-direction. Kolb's (1984) concrete experience, or learn by feeling, learning style can be seen in this initiative by the participants. It was also evidence that as adult learners they were seeking ways to make their learning experience demonstrate their capability at self-direction and being responsible for their own needs; learning by feeling, actively

experiencing the learning and connecting their feelings about the learning experience are all important aspects of Kolb's experiential learning.

Knowles's (2005) andragogy principles also focused on the adult learner's personal experiences in their learning. Adult learners bring a vast and diverse range of personal experiences that can impact the quality and quantity of their education that they can often draw to connect them to the new learning. The instructors used their teaching experiences to inform the way they currently teach.

Cory used her own personal experiences to help assist her students' learning in this principle. Cory talked about how her desire to teach developmental math was based from her experiences in becoming a teacher. She saw many learners who struggled with math issues typically had trauma-related issues. She used this knowledge to bring less fear and anxiety to learning math for students. She used humor, storytelling, games and other interactive techniques to help create a fun and light-hearted atmosphere in her students' learning experiences, as well as occasionally breaking out into a dance. She incorporated learning strategies such as mnemonics and technology such as a Smartpen for remembering and engaging with the content.

This principle is included in some techniques that are also associated with Kolb's (1973) experiential learning such as group discussions, simulation exercises, problem-solving activities and peer-helping activities. All four of the participants in this study used these types of techniques to assist their students in basic skills math learning process. Sally created student support teams outside of the classroom aligned with the students' outside and school schedules. Jamie used dice and other materials from

everyday life to illustrate the concepts he was trying to teach. Pat incorporated learning about the origins of math theories and was planning to incorporate more math history to connect to the present class activities and create a class climate to allow students to get to know each other through icebreakers and working together in small groups or teams.

The fourth andragogy principle (Knowles, 1973), readiness to learn, suggests that when adult learners are faced with a situation or problem that needs to be addressed, they are more likely to be ready to learn in order to solve the problem or resolve the situation. The four participants in this study recognized the students' needs and used strategies to help students learn the concepts and ease the anxiety. This also relates to the second theme noted in the data, *student needs*. Students' needs were addressed both collectively and individually as the instructors' were aware of their needs. The four instructors incorporated and varied teaching strategies to address students having difficulty with math anxiety, remembering the quadratic formula, and knowing when not to move onto a new section because the students were not grasping the previous section. The use of the pencasts in their teaching helped relieve students from furiously taking notes during lecture and being able to review the lecture over again during study time.

This principle is also visible in the data related to the fourth theme of *instructor flexibility* and *adaptability*. The participants tried to be responsive to the students' needs and address them as soon as possible. The use of a Smartpen helped this process. Pat mentioned that using a Smartpen allowed him to have a memory of what happened in class, to help him gauge the level of student understanding.

The fifth principle of andragogy (Knowles, 1973), orientation to learning, is about the adult learner is life-centered rather than subject-centered of pedagogical learning. Adult learners are invested and wanting to learn content that is relevant to their life, task, or problem. For these participants, learning about the pen and its use helped them incorporate this knowledge into their teaching life as a basic skills math community college instructor. They all made statements to their investment in teaching math and math at a community college. Cory felt that working in developmental math courses and in the community college were places that she could make a difference. She indicated that the use of the pen and pencasting practice exams online were methods she has learned to use to help her teach and make a difference in her teaching basic skills math to community college students.

The adult learning principles can be applied in part or whole with the essential feature of this theory is being flexible (Knowles et al., 2005). The four instructors in this study, as evidenced by their reported experiences used many of these principles in their teaching strategies in order to reach their students. Flexibility and the ability to adapt to the educational situations they were faced with were consistent among the participants. They continually looked for ways to engage, motivate, and teach their students math.

The four participants all described activities and techniques related to Kolb's (1973) experiential learning theory. They created the strategies and used the activities related in efforts to meet the needs of their students. Cory pencasts practice exams for her students with solutions and uploads them online. This allows students to learn by watching and doing. Other activities she used to address learn by doing and watching

were online math games. She used interactive activities with manipulatives that helped address learning by doing and learning by thinking; humor and storytelling activities in math helped her address learning by feeling style.

Pat used learn by thinking in his own efforts to incorporate more student-based learning into his teaching. In making changes in the way he teaches basic skills, he wanted to do more student-based work to get them more involved in the learning process. He wanted them to, in a way, teach each other. He has been thinking about having them make math videos or pencasts, have group discussions about the reality of a particular mathematical idea or a case study. He is thinking of ways to be able to incorporate more real life approaches to math and provide contextualized problems from different disciplines to be able to engage and teach his students.

Sally's approach of learning by doing was a product of her willingness to try anything that works. She was very willing to try the pen to reach and engage her students with math. She had no initial experience with it and willingly plunged in and continued to work with it despite issues with the technology and company. She also used this style when she noticed that her students seemed to lack technological savvy, and she found herself teaching technology use while teaching her students how to do math. She incorporated study support groups outside of the classroom as she found they really flourished and needed each other's support in learning math.

Jamie's approach of learning by thinking was evident in his interest in brain-based learning and metacognition research. He stated that he reads research related to these concepts and finds ways to incorporate what he learns into his teaching. He talked about

how he would try to focus his thinking about learning into his teaching. One example he gave was how what he read about metacognition and how we think, helped him focus more on how to teach his students to connect ideas. This resulted in his use of agendas in his teaching. He puts up agendas for the class so they can connect what they did yesterday with what is on today's agenda.

All four instructors used aspects of Kolb's (1984) experiential learning theory in their own process of teaching math and incorporating different modalities in their student's learning. Knowles's (1973, 2005) andragogy theory was also illustrated in their own teaching and professional development experiences and informed their current teaching practices.

Limitations of the Study

The main limitation in this study was a small sample size with a lack of representative data that would be required for transferability to larger populations. However, the small number of participants and lack of representative data still allowed for a more in-depth understanding of the participants' experiences with the UDL approach and its technology tool in teaching basic skills math to community college students. It is possible that experiences of these four instructors were more similar than not to other instructors who are motivated to respond to new modes of instruction. Another limitation to this study was the amount of time between the initial project experience and the interviews. The initial project happened during the academic year 2011-2012. Had this research occurred closer to the initial project, more concurrent data might have produced deeper results. Regardless, the study identified themes that did

provide insight into the experiences of teaching basic skills math at the community college.

Recommendations

The findings of this study identified four major themes: *instructor preparation*, *technology savvy and use*, *student needs*, and *instructor flexibility/adaptability*. These themes emerged from interviews exploring the professional development and teaching experiences of basic skills math community college instructors and the ways that their experience informed their current teaching practices. However, findings were limited to the scope of the study, which was focused on a specific experience in using UDL and a Smartpen in community college basic skills math instruction and small participant sample.

Other researchers may explore with a larger and representative sample size and expand the participant pool. Expanding the participant pool to the 113 California Community Colleges and any basic skills math community college instructors may yield a larger pool. A broader scope might include considering the experiences of similar instructors in other states that could provide a national perspective and larger representation of data and its transferability.

Other researchers might conduct a study around the original event collecting secondary data that might be available and a focus on the original Smartpen pilot project manager's insights. This study did not investigate the student side of the phenomenological event or the insights of the project manager in creating the project.

Further studies could investigate the use of a Smartpen in other disciplines to further use of UDL and its technology in higher education. This study focused specifically on basic skills math instructors and UDL in the community college. This inclusive view would further increase the research of UDL and its technology in higher education.

Implications

The research for this study was designed to explore to understand the experiences of basic skills math community college instructors using UDL approach and its technology tool in their teaching. The research questions included: (What were the professional development and teaching experiences of community college basic skills math instructors who use UDL and its technology tool, a Smartpen, in their basic skills math curriculum in a community college system? And in what ways has that experience informed their current teaching approach? The essence of the instructors' experiences and how elements of their experiences could be used to support other basic skills math instructors who may wish to apply these insights to their own teaching to community college students were identified.

This study's significance to positive social change is the use of UDL approach in community college teaching, specifically basic skills math, contributing to the current research. Millions of students are served in the California Community College system each year and many of those students are enrolled in basic skills math classes (CCCCO, 2012). In order for math to cease being a bottleneck or gatekeeper to successful completion towards the academic goals of obtaining a certificate or associate degree

and/or transferring to a transfer college or university, it is important to find a way to retain students and help them be successful in math to complete their education goal. The UDL approach in K-12 and special education has seen good success; however, there is a lack of use of this approach in higher education (Rose et al., 2002). This phenomenological narrative study helped further the knowledge in the field with regards to use of UDL in higher education through the understanding of the experiences of instructors utilizing UDL approaches and a Smartpen.

To that end, basic skills math community college instructors can increase their own understanding and use of technology and UDL, specifically a Smartpen, in their teaching. Basic skills math community college instructors can also engaging in best practices teaching meetings/trainings with other instructors to help increase their level of engaging and interactive activities and increase their adaptability/flexibility in their teaching.

Additionally the findings of this study indicated that a focused effort in the way basic skills math community college instructors are trained and prepared would be beneficial to basic skills math community college students. Master's programs for teacher training or math education could focus on training teachers to actively think of continual recruitment of future teachers in the students they will be teaching.

The findings also suggest that the way basic skills math curriculum in the community college is designed would be beneficial for students as perceived by their instructors. More interactive and engaging activities along with incorporating technology use, different learning modalities, project-based or real life connections and peer support

groups were all a part of the curriculum design these instructors perceived to be methods that reached their basics skills math community college students.

Conclusion

This study yielded information that provided insights to other basic skills math community college instructors in using a UDL approach and its technology tool, a Smartpen, in their teaching. By understanding the essence of the experiences of the instructors in this study, other basic skills math community college instructors may gain insight and consider possible strategies that they can immediately incorporate into their teaching. They may also gain insight as to their own motivation and engagement with adult learners and the principles of andragogy and experiential learning. Community colleges as a whole would gain basic skills math instructors who perceive their teaching methodologies and curriculum to help students succeed in basic skills math. Their best practices may inspire other colleges to hire and retain basic skills math instructors who engage in these teaching practices and are similarly motivated as adult learners.

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Appendix: Instructor Interview Protocol

Date:
Place:
Interviewer: Sunny Greene, Walden University Doctoral Student
Interviewee:

Initial Interview

1) Tell me about the life events that influenced your decision to become a math instructor.

2) Describe your experiences teaching basic skills math.

3) Tell me what your prior experience has been with Universal Design for Learning (UDL).

4) Tell me about how you became involved in teaching with a Smartpen.

5) Describe the training you received in using and teaching with a Smartpen.

6) Describe how you use the pen in your teaching. (Describe the interaction you had with your student note-taker).

7) What challenges have you encounter teaching with the pen?

8) What were the positive moments you have had teaching with the pen?

9) What did you notice about yourself personally and professionally since you began teaching with the pen?

10) What did you notice about your students' learning since teaching with the pen?

11) Describe how this experience affected your teaching.

12) Tell me what qualities are necessary for an instructor to teach with this pen successfully.

Second Interview

1) What other technologies have you used in teaching basic skills math to community college students?

2) How are those technologies different from a Smartpen in your teaching?

3) What challenges have you encountered using technology in teaching basic skills math?

4) What changes have you made or would like to make in the way you teach basic skills math?

5) Tell me about the UDL strategies you use and how they are working in teaching basic skills math.

6) What knowledge do you have of adult learning theory and how do you incorporate your knowledge into your teaching basic skills math to adult learners?

7) What knowledge do you have about experiential learning theory (learn by doing, watching, thinking, and feeling). How have you implemented these learning styles in your teaching of basic skills math to community college students?

8) What should other instructors know before they decide to use UDL in either basic skills math or any circumstances teaching adult learners?

9) Tell me about what kind of support you have had incorporating UDL and the pen into your teaching.

10) What other things can you tell me about UDL, the pen and your teaching that would help me better understand your experience?