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Abstract

Over the course of several decades, a large body of research focused on community colleges has accumulated based on the high need for remediation in mathematics, and has been associated with high attrition rates at that level. Reform efforts have been largely unsuccessful. This qualitative study was conducted so that the phenomenon of the requirement of remedial coursework in math could be examined. Each of the 13 participants in the study took part in one open-ended interview in which they shared their experiences, including their backgrounds and beliefs about learning mathematics throughout their years of school prior to, and including their enrollment in remedial mathematics coursework at the community college level. A conceptual framework that blended adult learning theories, or andragogy, with current research about the effect of mindset on learning mathematics was utilized to interpret information gathered. Delimitations of the study were the exclusion of students who signed up for remedial math by choice without requirement and students in need of special education services. The data gathered from the participant narratives led to conclusions that common experiences existed among remedial math students including a negative mindset about mathematics, a distorted view of mathematics as a discipline, and negative perceptions about community college structures including advising, course structure, and course pathways. Conclusions gleaned from this study contributed to the body of research on this topic based on alignment with recommendations from researchers that the community college experience for remedial studies be changed to include explicit work on self-regulation and metacognitive strategies, as well as increased use of active learning strategies, and changes in policy regarding course placement and pathways.

Keywords: andragogy, adult learning theory, mindset, phenomenology, remedial/developmental mathematics

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Chapter 1: Introduction

Introduction to the Problem

Over the past century, a damaging belief has been perpetuated in the United States that math ability is innate rather than obtained through hard work and practice (Boaler, 2016; Mighton, 2007). In fact, it has become quite common for adults to express their feelings about math as if one is either born with a math brain or without one (Boaler, 2016). A famous example of this can be found in the memoirs of psychologist, Stanley Smith Stevens: "The only way to get over an inferiority complex about mathematics is to learn some" (Stevens as cited by Ludden, 2017, para. 2). This was the response S.S. Stevens received when he mentioned his own perceived weakness in math to B. F. Skinner. Stevens used that comment as a revelation, and moved onto not only learning math, but using mathematics to develop his well-known power law (Ludden, 2017). However, the capacity to surpass negative experiences and difficulties with the subject of mathematics has not come as readily to many students who face enrollment in remedial math coursework upon entry to community college (Logue, Douglas, & Watanabe-Rose, 2017).

Mathematics at the higher education level has become a source of frustration for many students in the form of developmental courses designed to remediate students who cannot pass placement exams into college level coursework (Kolodner, 2016). Researchers such as Boaler (2016), Dweck (2014), and Mighton (2007) have pinpointed mindset in connection to belief about ability as a central issue regarding mathematics education in this nation. Boaler stated, "It is fueled by a single myth that's out there in our society that's very strong and very dangerous. And that myth is that there's such a thing as a math brain" (TEDx, 2016). A negative mindset about mathematics has become commonplace, as people in conversation discuss their feelings about the subject using descriptors such as anxiety, or even phobia (Burns, 1998). However, brain researchers have made solid conclusions that the concept of a fixed ability in mathematics is false, and that people with a growth mindset have been shown to have higher success with math

compared to those with a fixed mindset (Dweck, 2008). Yeager and Dweck (2012) found that when students of various ages throughout their education possessed a growth mindset, they were also more likely to exhibit resilience when facing challenges in their learning. Boaler (2016) has pointed out that as a collective society, we do not think one is born with an innate history or physics brain because there is wide acceptance that one must learn those subjects by studying and hard work. However, when people discuss mathematics, she has noted that even among educators of all levels, there is a widespread belief that some people have innate ability in mathematics, while others do not (Boaler, 2016).

Specific to the well-documented debacle of remedial mathematics in higher education, stakeholders such as institutional policy makers, politicians, scholars, professors, and tax paying members of society have been unable to reach agreement on how to reform programs to better meet student needs (Bailey, Jaggars, & Jenkins, 2015). The following statement, made in 1980, could have been written in 2018: "One of the problems many students encounter when they first come to university is that they do not have some of the basic mathematical knowledge and/or skills which are needed to facilitate the effective learning of their first-year courses" (Gonzalez-Leon, 1980, p. 81). Over time, the issue has only declined further so that, "Across the United States, more than half of entering freshmen discover they are ineligible for college-level coursework each year, most commonly in math" (Logue, Douglas & Watanabe-Rose, 2017, p. 79). According to Complete College America (2013), a national non-profit organization, remediation in college has become a "bridge to nowhere."

> Nationally, about 60 percent of first-time community college freshmen are assigned to developmental math, yet only 20 percent of them successfully complete their remedial requirements and then a college-level math class within three years. (Klipple, 2017, p. 1)

Key to this issue, coursework, originally intended to be a gateway for student access to a college education, has largely become a gatekeeper (Klipple, 2017).

Background, Context, History, and Conceptual Framework for the Problem

The issue of high numbers of students who enroll in remedial courses but fail has become key to all who have a stake in higher education (Pruett & Absher, 2015). In a comprehensive study completed in North Carolina which holds the third largest number of community colleges in the nation, it was revealed that enrollment in remedial coursework can have a negative effect on students and deemed students enrolled in such coursework as unlikely to complete a degree or certificate (Clotfelter, Ladd, Muschkin, & Vigdor, 2015). These results were similar to that of a study done in six community colleges in an urban setting whereby enrollment in remedial coursework itself had a negative influence on student persistence in college (Scott-Clayton & Rodriguez, 2012). Furthermore, Scott-Clayton, Crosta, and Belfield (2014) concluded in another study that one in four students placed in remedial mathematics courses were placed incorrectly.

In her book, *Math: Facing an American Phobia*, Marilyn Burns (1998) posited that prominent negative beliefs about mathematics arose from instruction beginning in the early childhood years. Burns (1998) also discussed how a negative attitude about math can influence student access to learning it. More recently, Dweck (2014) and Boaler (2016) have confirmed this notion through research with middle school, high school, and college students who increased their achievement by changing their mindset about their ability to learn math. While this new work has shown promise, it has not solved the overarching issue in our nation that high numbers of students exiting high school are unable to pass placement tests created by community colleges, thus landing them in a series of remedial courses that statistics show they may not be able to pass (Clotfelter, Ladd, Muschkin, & Vigdor, 2015).

Despite reform efforts in both the K-12 and higher education realms, the issue of failed remediation remains a difficult one to address (Bailey, Jaggars, & Jenkins, 2015). Historically, remedial math students have been studied using assessment and enrollment data with very little personal information considered other than basic demographics. For this study, a conceptual framework designed to examine student characteristics in a detailed manner was used as a means to analyze the personal narratives of students who had actually experienced enrollment in remedial coursework. The adult learning theories of Tinto (1975), Knowles (1980), and Mezirow (1991) alongside the concepts of mindset as proposed in current research from Dweck (2014) and Boaler (2016) were considered. Tinto (2012) stated that a key characteristic of students who persist through college is what they expect of themselves, a stance which correlated well with the concept of development of a growth mindset or lack thereof (Boaler, 2015; Dweck, 2014).

While community college students range from early in their adulthood to older adults, it has been found that instruction that targets the key adult learning components from the work of Knowles (1980) including the need to know, self-concept, readiness, and motivation have become very effective with every age group (Aubrey & Riley, 2015). Specifically, Knowles' revised version of his theory of andragogy contains the idea that student learning needs can be viewed on a continuum that ranges from teacher-directed to student-directed learning (Merriam, 2001). Knowles' theory of andragogy has evolved to encompass the idea that the needs of learners should be considered in terms of independence versus dependence on their instructors regardless of their age (Merriam, 2001). In their research, Kim, Sax, Lee and Hagedorn (2010) pointed out that community college students have unique qualities that may differ from their four-year college counterparts. Thus, Knowles' revised theory of andragogy was useful in analyzing community college student perceptions about learning math as a means to discern self-directed versus dependent learner characteristics among participants (Merriam, 2001). The concept of a

continuum was also discussed by Dweck (2008) in her original work on mindset which revealed the idea that all students possessed variances in their belief in themselves as learners ranging from a fixed to a growth mindset depending on what subject area they were working. Thus, the concepts presented by Mezirow (1991) have been added because of his emphasis on the importance of critical reflection as students get older, which is likely to impact a student's capacity to develop a growth mindset in the area of mathematics despite previous challenges. In short, the mindset that remedial math students in community college have about learning mathematics was examined through the lens of learning theories that encompassed self-reflection, levels of self-directedness, persistence, and motivation.

Statement of the Problem

Open enrollment policies with affordable tuition at community colleges have allowed more students than ever to enter college with the goal of achieving a certificate or degree (Bailey, Jaggars, & Jenkins, 2015). However, a vast number of these students are considered unprepared for the rigor of college level mathematics and are placed in a sequence of remedial courses often resulting in student attrition (Bailey, et. al, 2015). The issue is complex as it begins with open enrollment followed by high numbers of students requiring remediation, moving to low numbers of students completing that remediation, and ending with those students never completing credit bearing math courses that would have contributed to the attainment of a degree or certificate (Logue, Douglas, & Watanabe-Rose, 2017). Increased pass rates for remedial coursework in mathematics has been identified as a means of ameliorating the issue (Logue, et al., 2017). However, a multitude of studies conducted on the topic of math remediation in community colleges had conflicting results with regard to how to achieve that goal (Crisp & Delgado, 2014).

As of 2015, 70% of jobs in the United States required some type of higher education (Darling-Hammond, 2015). Yet 60% of students entering 2-year institutions have been deemed

unprepared for college level coursework (Logue, et al., 2017). Furthermore, based on a 2016 report from the National Center for Educational Statistics, only "About half of remedial course takers beginning at public 2-year institutions (49 percent) completed all the remedial courses they attempted" (p. 1). Seventy-five percent of students who begin a remedial course sequence never successfully complete a college level math course, preventing them from completing a degree or certificate (Bahr, 2013). Several researchers have implied there is a need to study this topic from a different perspective than previously done (Bahr, 2013; Bailey, Jaggars & Jenkins, 2015; Crisp & Delgado, 2014). For example, prominent researcher on this topic, Bahr (2013), stated that a qualitative approach may be useful rather than continued quantitative studies. In other words, an approach to research on this topic with information beyond enrollment statistics could prove beneficial. Based on this call for more information that might illuminate unique characteristics of remedial math students, this study will addressed the problem through the lived experiences of students currently enrolled in remediation upon their entry to community college.

Since few studies about remedial mathematics students in community college had been completed from the student point of view, it was determined for this study that key factors or characteristics about them previously overlooked in the design of remedial coursework could be discovered and examined. The rationale for this was that to help increase success rates of students in terms of completion of remedial coursework and the persistence through a degree or certificate, information about the lived experiences of students could be better understood and then utilized in reform efforts. An example of an important aspect of the problem that might be understood more deeply from the student perspective is based on current researchers that have indicated a prevalence of a negative mindset coupled with math anxiety (Boaler, 2015). For example, in a study done with high school students identified as candidates for remediation, a bridge program used with them increased student preparedness, not only with content, but created a change in

mindset about the ability to succeed in college coursework (Cevallos, Cevallos, & Webster, 2016). Tinto (2012) proposed the need for a roadmap in order to create the conditions necessary for success.

Purpose of the Study

The purpose of this study was to allow students experiencing a requirement of remedial coursework in mathematics to share their personal backgrounds, opinions, and perceptions about learning math so as to make recommendations for course improvement since so few students are able to complete it successfully. A key focus was to uncover more about this phenomenon from the student perspective. During the interviews, information on common characteristics such as those discussed by Tinto (2012) including family background/responsibilities, reasons for enrolling in college, expectations of self, and levels of social connection at the community college setting were collected. Motivation, purpose, learning preferences, and belief about the importance of learning a subject as described by Knowles (1980) was also considered. Finally, the ability to critically reflect on oneself as a learner as depicted by Mezirow (1991) alongside the concept of mindset as described by Boaler (2016) was combined to extricate key themes about remedial math students. With the combination of learning theories as a lens, student perception and characteristics have been examined.

Research Question

In this study, the following question was researched: What is the lived experience of students who have been enrolled in remedial coursework in community college in terms of their history as learners of mathematics? To do so, an open-ended interview protocol was utilized to prompt participants to convey their life experiences as math learners from their K-12 years, to describe their personal characteristics in terms of their learning needs, and to describe their opinions and feelings about having to take remedial coursework. Close attention was given to

student narratives to discover their mindset about learning mathematics, how they engaged in reflection about learning, and how they described the support systems in place received during their tenure as a student of mathematics over the course of their education.

Research Sub-Questions. To obtain in-depth answers to the research question, the following sub-questions were used to guide the use of clarifying questions during the interviewing process:

1. What themes emerge when participants describe their history as a learner of mathematics?

Seeking answers to this question was a means to find out to what degree participants had traditionally struggled with math, and if they could identify a specific time when difficulties began. Based on concepts from Tinto (1975), it was anticipated that when students were given the opportunity to discuss their learning of math over time, they might identify external barriers they have had to learning math such as having to change schools, not having support at home, or not feeling socially connected to their school community.

2. How do participants describe any change throughout their years as math students with regard to their personal characteristics, learning preferences, or needs?

Answering this question was a means to address the concept of learning style as perceived by students in remedial math. Participants' description of what they believed helped them learn mathematics, as well as what they believed hindered them, allowed for the analysis of their narratives from the perspective of learning style. Personal learning preferences and the concepts of persistence and motivation as described by Tinto (1975) were examined. Some of the core principles of andragogy including self-concept of the learner, readiness to learn, and prior experience was also considered (Knowles, Holton, & Swanson, 2012). As discussed previously, Knowles' (1980) original theory evolved over time to include a range of ages of students because

"there are a variety of other factors that affect adult learning in any particular situation, and may cause adults to behave more or less closely to the core principles" (Knowles et. al, 2012, p. 3).

3. What do participants reveal about their overall mindset about learning mathematics in connection with being placed in a remedial math course at the community college?

As discussed by Dweck and Yeager (2012) as well as Boaler (2016), a person's mindset about learning math has been correlated with how well it is learned in terms of one's willingness to persevere through challenges. Furthermore, results of previous research has revealed that the concept of having to take a remedial course may contribute to the low success rate of such courses because of negative emotions (Perin, 2011). In other words, student mindset about taking remedial math coupled with an overall negative mindset about learning math was considered as a possible contributing factor to the low success rate of students in these courses. In addition, a great deal of research has led some scholars to draw conclusions about the existence of a correlation between emotions and learning. According to Rager (2009),

> What is common to recent findings from research into how the brain works is support for the critical role that emotion plays in the process of learning and that this applies to all types of learning including self-directed learning, the most common form for adults. (p. 27)

Thus, attempting to answer the sub-question addressing mindset served as a means to uncover emotions participants may have had in association with their experience with enrollment in developmental mathematics.

Rationale, Relevance, and Significance of the Study

As mentioned previously, remedial mathematics at the college level comes at a cost of $7,000,000,000 nationwide with an extremely low success rate, which makes this issue a significant problem in the eyes of many stakeholders of higher education in the United States

(Scott-Clayton, Crosta, & Belfield, 2014). Additionally, "This figure accounts only for the direct cost of remediation: it does not include the opportunity cost of time for students enrolled in these courses nor does it account for any impact, positive or negative, that remediation may have on students' future outcomes" (Scott-Clayton, et. al, 2014, p. 3). Overall, policy makers at the college level have not looked at the problem from the student perspective, but rather have relied largely on quantitative research with a focus on test scores and demographics and/or enrollment behaviors (Bahr, 2012). Also, a distinction needs to be made between the idea of college-readiness and that of academic preparedness (Barnes, Slate, & Rojas-LeBoef, 2010). This distinction was also supported by Hawley and Harris (2006) who suggested that not enough individual attention on student needs has occurred at the community college level, even though one of the core responsibilities of such institutions based on an open-door policy, has been to provide a pathway for students who might not otherwise have been able to obtain a higher education degree. While the concept of readiness and academic preparedness are connected, the conclusions provided by researchers in the body of literature available mostly include discussions on academic content knowledge and links to demographics, but offer no clear-cut strategies or best practices for how to increase student success based on learner characteristics and needs.

According to Bryk, Gomez, Grunow and LeMahieu (2015), the concept of connecting ideas from research to create a linked community with the purpose of developing a paradigm of learning how to improve programs is needed at the institutional level. However, one key element not mentioned in their proposal, nor in most of the current body of research, was the perception of this problem from the student point of view. When students enter remedial coursework at a community college, little has been discovered about them as individual learners other than their placement exam score. One goal of this study was to find out more about these students both as people and learners as a means to contribute to the improvement of remedial coursework. Results of this

study may be used fill this gap in the research based on allowing students to convey their perceptions, opinions, and background experiences about mathematics. Results could lead to the development of new ideas about what shifts in course content, course sequences, and/or different teaching methods might be warranted. In short, the rationale for proposing this study was that not enough information on remedial mathematics has come directly from students. Reflections of students who had currently experienced the situation of being placed in remedial math has added to the current body of research currently used to reshape programs.

As previously stated, Dweck (2014) and Boaler (2016) have both given strong evidence with their research that there has always been more to this issue than missing mathematics skills, and have indicated mindset as a key factor. Alhassan (2012) and many others have framed the issue in terms of social equity. Previous researchers of adult learning including Tinto (1975), Knowles (1980), and Mezirow (1991) have indicated mindset as a factor in terms of motivation, persistence, and the ability to engage in critical reflection. This study was conducted with these aspects in mind, in order to produce results that could be used to create feasible and sustainable solutions that might lead to increased success levels of students who enter college in need of remediation.

Definition of Terms

For the purposes of this study, these categorical meanings were used for the following terms:

Bracketing. A means of mindfully putting aside personal beliefs, opinions, and preconceptions when conducting phenomenological research to establish validity (Chan, Fung, & Chien, 2013).

Cut-off scores. A commonly used term for an individual institution's determined score for appropriate placement in coursework. In some states, such as Florida, the cut-off score for

required remediation is determined at the state level to be followed by community colleges of that state (Bailey, 2009)

Common Core State Standards. The national curriculum agreed upon in the United States by 42 of the 50 states and the District of Columbia as of 2010 ("Preparing America's students for success", 2017).

Interpretive Phenomenological Analysis (IPA). A way to interpret phenomenological data using the acceptance that anyone's understanding of the world comes from their interpretation of it (Reiners, 2012, Smith, 2017). This includes both the investigator and participants in a study.

Mindset/Growth mindset. Degree to which one believes they have the potential to learn new content as discussed in recent neuroscience studies of students, particularly in mathematics. Current scholars in this area include Boaler (2016), Dweck (2014).

Placement test/exam. An assessment given upon entry to college that determines readiness for credit-bearing coursework in mathematics (Bailey, 2009).

Remedial /developmental mathematics. Interchangeable terms for a course or sequence of courses, either credit-bearing or not, that college students who fail an institution's placement test must take prior to taking mathematics courses that count towards their degree (Bailey, 2009).

Student learner characteristics. Specific to the conceptual framework of andragogy and mindset this term refers to readiness factors, persistence indicators, self-reflection aptitude, attitudes about teachers, attitudes about education, and beliefs about intelligence/ability (Knowles, 1980).

Delimitations and Limitations

In terms of delimitations, boundaries were mindfully set for the subjects to be included because the lived experiences of high school graduates who had entered community college with little hiatus between obtaining their diploma and signing up for college coursework was of high

interest. However, an unexpected population presented itself when two participants volunteered who had gone directly into the military for a few years before beginning community college. Therefore, the original limit to those that had completed high school within the past five years was changed to eight years to accommodate for this. A delimitation was set not to include students with learning disabilities for which they would have had accommodations based on the American with Disabilities Act. Next, a detailed set of interview questions was not used, so as to allow participants to tell their stories about themselves with the freedom to discuss their educational background in mathematics as far back or as recent as they chose. This strategy allowed for the broad perceptions and ideas of participants to be shared without constraining them to answer a narrowed down set of questions. If participants were unable to generate their own detailed narrative, a set of prompting questions were used to assist them, which were further developed after a pilot study of three participants was conducted (See Appendix A).

Naturally, some limitations were present despite careful effort to minimize them. This type of research required the analysis of perceptions and opinions of the subject narratives about themselves, and while I worked to bracket off my personal opinions and background on this subject, complete elimination of the subjective nature of phenomenology was already acknowledged to be impossible as specified by Heidegger's interpretative phenomenology (Reiners, 2012). In other words, participants engaged in a process of self-reporting and were free to include or exclude details about themselves. Afterward, a process of analysis was used in which I bracketed my opinions and perceptions throughout the process, but engaged in a process in which I used my own background in the area of mathematics education to interpret the meaning of the information participants provided. Despite the innate limitation found with this type of study, valid results could be discerned based on achieving data saturation and review of the process by professional colleagues within the field of education.

Summary

As referenced earlier, math remediation at the community college level has become a nationwide problem affecting thousands of students each year, to the extent that it has emerged as a key barrier to a higher education degree or certificate (Bailey et. al, 2015; Chen & Simone, 2016). Many studies, mostly quantitative in nature, have been conducted to ascertain root causes for the high failure rate of remedial coursework (Bahr, 2012). New reports have revealed initiatives to create a more cohesive pathway for students from high school to college (Parham, Conner, & Gillkey, 2016). While such innovative plans may help future community college students, in this study it was proposed that more information about the students who had recently experienced remedial mathematics be explored so that changes might be made to support the current population. For example, if it was found that students found technology a barrier rather than a pathway to their understanding of mathematics, course structures could be adjusted. Students could have indicated that they learn best when placed in cooperative groups, while others may have found that they learn best by independent practice. Also, Boaler (2016) suggested that many students do not believe they can learn math, thus the impact of mindset was examined closely.

In this study, 13 participants were interviewed and given the opportunity to discuss themselves as learners of mathematics. Students were encouraged to share their learning experiences as far back as they chose, were asked to consider their learning styles, and discussed their perceptions about the importance of mathematics in their lives. Analysis of student interviews was conducted through the use of a conceptual framework blending the learning theories of Tinto (1975), Mezirow (2000), and Knowles (2012) coupled with current research on mindset stemming from the work of Dweck (2014) and Boaler (2016).

Once a full analysis was completed, recommendations on the topic of course design, student advising, and the focus of future research on this topic was compiled. Results of this study

might be used to inform practitioners from secondary schools and community colleges as they continue to reform course design and teaching methods to meet the needs of the diverse population of students in the United States. Ideally, the redesigning of courses should maximize student access to learning, and positively change how mathematics is taught at the community college level. It was also speculated that improvements in advising or coaching on the development of study habits, or possibly the fostering of more social connections in the community college setting was needed (Tinto, 1993). Finally, because this study included subjects who completed high school fairly recently and were beginning community college, results could be utilized as a means to increase communication between public school systems and community colleges serving the same population.

Chapter 2: Literature Review

More students than ever are making the decision to enter community college based on the increased need for a degree or certificate in the 21st century job market (Knelper, Klasik & Sunderman, 2014). In fact, the low cost and open enrollment policies found in most community colleges have become a means to increase equity in education by allowing access to a wide array of non-traditional and diverse populations of students (Knelper, Klasik, & Sunderman, 2014). However, by the time they reach high school graduation, many students have found they have fallen short in math placement at the college level. As a result, many studies ensued with a wide variety of focal points and differing conclusions with the goal of discerning why so many students need remedial courses, and why there is such a low pass rate in such courses (Bailey, 2009).

Introduction to the Literature Review

Study topic. In this review of literature root causes of the low success rate of remedial mathematics students at the community college level were investigated. The chief concern has been that the majority of students required to enroll in remedial mathematics courses upon entry to community college do not persist to complete a degree or higher education certificate (Chen, 2012). Included in this review of existing literature is the work of researchers who have investigated student response to remediation, the characteristics of remedial students, as well as institutional policies on remedial programs. One goal was to discover the background of students enrolled in remedial mathematics, their perceptions about the experience of placement in remedial coursework, and the presence of factors in either their personal lives, or in the structure of the program they were enrolled in that could be construed as barriers to their success.

Context. Studies from across the nation have been analyzed in order to gain perspective from various institutions serving a wide array of populations in community colleges. I have

compared the types of studies and programs different states have attempted with their community colleges to address the issue in order to present a case for the need for further study.

Significance. The high number of students who enter community college and withdraw without obtaining a degree or certificate has become an impactful societal issue. "At least 70% of U.S. jobs now require specialized knowledge and skills, as compared to only 5% at the dawn of the last century" (Darling-Hammond, 2015, p. 2). It has become increasingly important that high school graduates continue their education in order to receive the training they need to fulfill the qualifications needed for 20-first century careers. Yet it has become commonly known that many students who begin their higher education at a community college never complete it (Quarles & Davis, 2017). Success in mathematics in particular has been pinpointed as one of the most significant factors associated with low persistence rates at the community college level (Logue, Douglas, & Watanabe-Rose, 2017). The connection between math remediation requirements and the lack of persistence through community college is strong, and affects thousands of students in the United States each year (Chen & Simone, 2016). As a result, the literature was examined on this topic to investigate root causes, as well as develop this study.

Problem statement. A vast number of students who enroll at community colleges are considered unprepared for the rigor of college level mathematics, and are placed in a sequence of remedial courses which often result in student attrition (Bailey, Jaggars, & Jenkins, 2015). It is a significant problem that there exists little data about the educational backgrounds and personal characteristics of students enrolled in such coursework, aside from the results of a community college placement exam. (Attewell, Lavin, Domina & Levey, 2006; Bettinger, Boatman, & Long, 2005; Ngo & Kwon, 2015). Previous researchers have criticized the design of remedial coursework, and in some cases have blamed required enrollment in such courses for the failure

these students experience in progressing through a program (Attewell, Lavin, Domina & Levey, 2006).

According to Ngo & Meguizo (2016), college placement tests and the inconsistency of determining cut-off scores from one community college system to another have led to incorrect placement of students which in turn has had negative effects on students "including initial math enrollment and completion of gatekeeper math courses" (p. 194). On the other hand, some policy makers have concluded that students who cannot handle college level coursework should not have been admitted to college in the first place (Attewell, Lavin, Domina & Levey, 2006). This attitude goes against the notion of equity, and "supporters of developmental education therefore construe the controversy over remediation as an attack on access to college" (Attewell, Lavin, Domina & Levey, 2006, p. 887).

Community college leaders have remained steadfast in their support of open enrollment policies, but have not determined how underprepared math students would best be supported. This study has focused on finding out more about the lived experiences of students enrolled in remedial coursework for math. Throughout the process, the background of students enrolled in remedial mathematics, their perceptions about the experience of placement in remedial coursework, the presence of factors in their personal lives, and the structure of the academic program that acted as barriers to their future success was considered. The shared experiences of students enrolled in remedial mathematics at a community college were examined with the intent of discovering aspects that could lead to the improvement of developmental math coursework at community colleges in the future.

Organization. Throughout this review of literature, it has been established that there is a need for further study of students entering community college with a need for remediation in mathematics. In order to do so, a lens of adult learning theories was used as a conceptual

framework. This allowed for an unpacking of key findings on the existing research on the topic including studies by researchers who have analyzed the effectiveness of programs across the nation, key student characteristics linked to a need for remediation, as well as studies that have attempted to discover better methods of delivering instruction to remedial students.

Conceptual Framework

The conceptual framework for this study stemmed from ideas of prominent adult learning theorists. "Theories on student development in community college education are paramount for researching and discussing issues of persistence and retention for first-year students" (Hawley & Harris, 2006, p. 120). Specifically, Tinto's (1975) theory on persistence, Knowles' (1984) principles of andragogy, and Mezirow's (1991) concept of critical reflection as a key component of transformational learning theory were considered. This triad of theorists allowed for the creation of a structure through which to analyze information gathered on remedial mathematics students. Specific to the idea of student persistence based on the work of Tinto (1975), responses to questions about experiences and perceptions about learning mathematics and their placement in remediation in terms of self-expectations, perceived levels of support, degree community involvement, and goal commitment were analyzed. The work of Knowles (1980) was used to analyze the degree to which students were functioning as adult learners in terms of their self-concept, motivation, and their perception of the relevance mathematics had to their future goals. Finally, the aspect of critical reflection from the work of Mezirow (1991) was utilized to inspect the degree to which students possessed mindfulness about themselves as learners.

Student persistence. Over time, Tinto's work evolved from his 1975 theory to become a more inclusive theory in terms of outside factors such as demographics and included ideas specific to the two-year institution. Specific to this study, societal, economic, and family backgrounds were viewed as possible influences on remedial math students in terms of their self-perception as

learners (Tinto, 1987). Also considered was the concept of academic integration extending beyond the classroom which Tinto (1998) pointed out was of great importance for students in two-year institutions. For example, Tinto (1998) posited that being socially connected with an institution beyond simply going to class was linked to higher student success. It could be construed that a complex mixture of self-drive and social interaction may lead to either persistence through a program or attrition (Tinto, 1975). When students encounter the prospect of being behind before they begin their quest for a higher education degree, levels of social connection to others in that endeavor may be key.

According to Tinto (1975), a combination of academic performance, interactions with teachers, interaction with peers, and participation in extracurricular activities are the factors that contribute to a student persisting through a degree. In this case, it is possible that students enrolled in a remedial course could feel a particular disconnect since they were not able to place into a credit-bearing math course. Thus, for the purposes of this study, it was important to inspect data from students indicating goal commitment coupled with their perceptions of their experiences as learners of mathematics. As his work continued to grow over time, Tinto (1993) pointed out that reporting on individual students and individual institutions would be key to continuing to unravel the issue of high rates of attrition among college students. For this study the issue of low persistence rates specifically among remedial math students was considered using Tinto's (1975) concepts about persistence to move towards discovering why so many students taking remedial mathematics do not complete community college and what strategies might be implemented to change this.

Andragogy. The global view of adult learning, termed andragogy, has become best known through the work of Knowles (1980). Knowles described the purpose for educating adults as a means "to develop competent people who are able to apply their knowledge under changing

conditions" (p. 19). Over time, this theory evolved to include a wide variety of learners from various ages and is particularly pertinent to the varied array of students that attend community college. For example, while some students may be attending community college full-time never having held a job, other students may have taken on much larger responsibilities for their families early in life. As a result, community college students may vary in terms of how their characteristics align with Knowles' (1980) Six Principles of Learning. "An instructor using andragogical principles focuses more on being a facilitator of learning rather than a transmitter of knowledge and evaluator" (Taylor & Kroth, 2009, p. 3). Theoretically, students entering college should be moving from being dependent learners to ones that are more self-directed in their learning process (Corley, 2011). Bearing the principles of andragogy in mind, in this study I looked to discover student learner characteristics including intrinsic motivation, perceptions of math as a relevant subject to study for their future, and the degree to which participants were actively responsible for their own learning.

Learning as transformation. Throughout one's education, strong beliefs develop with regard to learning and the ability to learn itself. Specific to this study, there are strong opinions and beliefs regarding the area of mathematics, as well as the concepts of critical reflection related to self-efficacy. The conclusions of Dweck (2008) and Boaler (2013) have revealed a strong link between the mindsets of students and their ability to learn mathematics. Both have completed a multitude of studies, the results of which have shown a strong connection between the belief that one can learn and the actual ability to learn mathematics (Boaler, 2013). "The implications of this mindset are profound -- students with a growth mindset work and learn more effectively, displaying a desire for challenge and resilience in the face of failure" (Boaler, 2013, p. 143). Coupled with the concept of the strong effect of mindset, Mezirow's (2000) ideas on critical reflection were connected as part of transformational learning theory of adults as a means to

analyze the research results. This was done because "Awareness involves recognition of how we have been influenced by our culture and biography to acquire these limitations in the first place" (Mezirow, 1991, p. 119). Students' ability to reflect on their experiences and on themselves as learners, particularly when asked to consider how it felt to re-learn content they previously failed to master shaped my framework for analysis. "As individuals reflect on and discuss their assumptions about the world, they often experience a shift in their frame of reference or worldview" (Mezirow, 2000 as cited by Teacher Excellence in Adult Learning, 2012, p. 1). It can be construed that woven together with a learner's background knowledge of a content area are various levels of self-perception and self-efficacy (Knowles et. al, 2012). Consequently, in this study the presence or absence of opportunities to critically reflect in students' depiction of their experiences as learners of mathematics was considered.

Review of Research Literature

For the past several decades, many researchers have sought to discern whether developmental mathematics courses at the higher education level are effective or not. There have been conflicting results in the literature with no definitive solutions as to how institutions should shape their policy to remedy the issue for all students. Bahr's (2010) report based on four separate studies claimed there is evidence to support the efficacy of remediation at the higher education level. On the other hand, Bettinger & Long (2008) have made claims that only students on the margin of needing remediation have shown high levels of success. Further, some studies have indicated that the mere notion of having to take a remedial course can negatively impact a student's chance of obtaining a degree (Perin, 2011). It can be inferred that this issue might impact student enrollment, a school's reputation, and a school's ability to fully prepare students for the workplace. "Over forty years ago, Patricia Cross asserted that higher education must 'democratize' its colleges and universities"

(Engstrom, 2008, p. 5). In essence this was meant to inspire higher education policies to embrace a philosophy of equity by giving access to a more diverse group of students (Engstrom, 2008). Open enrollment policies of community colleges could be seen as the effort Engstrom referred to, but as stated earlier high numbers of students currently enter such schools in need of remediation, but less than half of them do so successfully (Chen, 2012).

While many institutions, particularly community colleges, have conducted research and implemented various programs and strategies to remedy the problem, no notable progress has been made. This has led to discord among researchers in terms of what actions should be taken. On one hand, some researchers on this topic have called for a complete overhaul of the structure of community colleges (Bailey, Jaggars & Jenkins, 2015). On the other hand, researchers such as Goudas & Boylan (2012) have maintained the notion that such dramatic shifts are not necessary. According to Bol, Campbell, Perez, & Yen (2016), the changes needed involve developing coursework that explicitly includes instruction in self-regulation of metacognition, not necessarily changes in academic content. In a study of 116 community college students, it was found that students who were required to engage in such reflection showed stronger gains in math achievement than students who were given the same instruction without that requirement (Bol et. al, 2016).

This issue has affected whole university systems, such as in California, where math remediation requirements were changed altogether to eliminate repetition of coursework completed in high school (Warth, 2017). This dramatic shift in programming may reveal a new trend towards alignment of college programming to what is truly necessary for jobs, or it might be construed as a means to attenuate the standards to achieve higher pass rates. These differing perspectives are indicative of the fact that there is no nationwide consensus regarding remedial education at community colleges. Discord has continued among those

who want high academic standards in a traditional sense, versus those who want more equity in access to higher education (Melguizo, Kosiewicz, Prather, & Bos, 2014). Based on such a variance of response to the issue, it is important to contextualize the matter as it has occurred over time.

Historical context of college math remediation. Many large studies have been conducted over several decades with results that have indicated how impactful the problem of remedial mathematics had become. For example, one large study known as NELS: 88 showed that 40% of all students needed some type of remediation in college, with 52% of those students coming from urban high schools (National Center for Education Statistics, 2015). Based on another study, Bahr (2008) determined that for those students who remediated successfully, their overall persistence rate in completing their degree was comparable to those students who did not require remediation. In another of Bahr's studies it was concluded that "although intended to reduce disparities between advantaged and disadvantaged groups, in the end those who most need remediation are the least likely to remediate successfully" (Bahr, 2010, p. 179). Bettinger & Long (2005) conducted a longitudinal study of college freshmen in six Ohio community colleges beginning in 1998. The researchers for this study sought to correlate readiness factors with need for remediation in college (Bettinger & Long, 2005). They indicated results that students of similar backgrounds who completed remedial coursework in mathematics had a significantly higher chance of completing a degree than those that did not. It was also concluded that the success rate was higher among those with the least need for remediation (Bettinger & Long, 2005). However, Bahr's (2010) quantitative study on remedial math students revealed positive results regardless of how dire the need was for remediation. Bailey (2009), in a research study designed to review a collection of different studies on the topic of remediation,

indicated that of the students that enrolled in developmental math in college, only around 30% of them passed those courses despite their demographic variables. As stated by Adelman (1996), "The truth about remedial work - it's more complex than windy rhetoric and simple solutions suggest" (p. 56). Braxton, Milem, and Sullivan (2000) correlated race, gender, and social class with learner behaviors in college that led to attrition. Through this study, an overarching need for improved social integration was shown. However, historically not many researchers took socio-cultural aspects of the problem into consideration, despite the fact that Tinto (1975) had already developed his theory on this need.

Current trends in research for math remediation. Several key trends were discerned from the most recent literature in this area. For one, some quantitative studies on the effectiveness of new programs compared to traditional coursework emerged. Larger statewide comparisons among community colleges have also been completed. The trend in K-12 systems in which an individualized approach became an expectation of teachers has become an influence since "educators understand that the business of coming to know our students as learners is simply too important to leave to chance—and that the peril of not undertaking this inquiry is not reaching a learner at all" (Powell & Powell, 2016, p. 21).

An example of a quantitative study of a redesigned program took place in Hawaii, in which 3,690 community college students were compared, as some students were given the redesigned coursework while others remained in the existing program (Okimoto & Heck, 2015). Specifically, increased levels of persistence were looked for in reference to the work of Tinto (1975). "Students who are actively engaged in the learning process have a greater likelihood of success in the classroom and continue to remain at the institution" (Okimoto & Heck, 2015, p. 645). On a larger scale, the National Center for Academic Transformation has been involved with course redesign projects involving 37 institutions for over a decade (Twigg, 2011). With increased student

engagement as the focus, NCAT with its partnerships was able to increase the success rate of developmental math coursework by 51% (Twigg, 2011).

In terms of larger statewide studies comparing remedial programs across schools, and to contrast results found in Hawaii, a recent report from North Carolina was useful. "North Carolina serves as an appropriate state for examining this question because of its large public community college system with 58 public colleges that cover the whole state" (Clodfelter, Ladd, Muschkin, & Vigdor, 2015, p. 355). Despite being the third largest community college system in the nation with a firm commitment to its programs, this study revealed overall negative results with regard to remedial math programs (Clodfelter et. al, 2015). In fact, the study found no evidence to support the idea that remediation for traditional college age students worked, but that remediation "actually reduces the probability that students will succeed in college or that they will ever pass a college-level course in the remediated field" (Clodfelter et. al, 2015, p. 371). The overarching conclusion made from this quantitative study on pass rates across the state was that students' math struggles needed to be addressed at the high school level.

However, in a qualitative study done in six different classrooms in two community colleges in an urban setting, it was found that the primary mode of instruction was traditional lecture style with a focus on procedural rather than conceptual understanding (Cox, 2015). This study was an attempt to get a deeper look inside what occurs in developmental math classrooms in order to glean new ideas on how to improve them. Cox (2015) gathered data on teaching practices through observation in an attempt to uncover what she termed "the black box" of teaching practices in such courses. As a result, she posited that institutional policy needed to be distanced from teacher qualifications and intended curriculum, but instead should be focused on what was actually occurring in the classrooms of remedial math courses. The recommended focus from Cox (2015) was an "increased interplay between enacted curricula and the development of students'

mathematical proficiencies, and that organization level conditions be required to interrupt the default approach to developmental math instruction" (p. 283). Thus, while the previously mentioned study done by North Carolina had bleak results, both the results found through NCAT and the qualitative study done by Cox (2015) has served as a reminder that researchers in this area seem to have failed to consider the idea that community college programs and teaching practices should be changed, rather than placing full responsibility on high schools. Further, upon reflection on his own collection of research Bahr (2013) concluded that a new approach pertaining to remedial students be explored since no conclusive answers were discovered in terms of getting students in need of developmental coursework to complete the full sequence of coursework required, and then persist in their goal to complete a degree.

Zientek's (2013) study which utilized a survey instrument on community college students in Texas found a need for students to receive interventions much earlier, and that policy adjustments should be made so that if warning signs appear, teachers could act quickly before a student has failed beyond recovery. These findings included the need for students to be taught self-regulatory behaviors for the development of higher self-efficacy, which supported the notion that adult learning needs should be considered when revamping programs (Zientek et al., 2013). Researchers have suggested that not enough individual attention on student needs has occurred at the community college level even though one of the core responsibilities of the open-door policy institution has been to provide a pathway for students who might not otherwise have been able to obtain a higher education degree (Hawley & Harris, 2006).

Institutional leaders have tended to point blame for this phenomenon on the K-12 schools for the increasingly large number of underprepared students. As of 2009, the number of students that needed developmental coursework rose steeply to two million per year (Boylan, 2009). "According to a new report that looked at a survey of 70,000 community-college students, 40

percent of students who said they averaged an A in high school reported that they needed a developmental course in at least one subject" (Zinshteyn, 2016, p. 1). However, it was purported by some that this was not just a K-12 preparation problem, but an issue with colleges and how they have traditionally assessed readiness, as well as how they designed coursework (Zinshteyn, 2016).

Nationwide, there has been a call for policy changes within institutions to better meet the needs of underprepared college students. In fact, the 2010 Southern Regional Education report recommended that the idea of college readiness be thought of not as a new initiative for institutions to take on, but rather the conceptual framework through which Pre-K through 16 schools and institutions base their policies. Bailey (2009) posited that not enough work has been done to discover the exact differences between students who need to take developmental math and those who do not. Based on a study specific to examining the unique characteristics of community college students in general, different approaches to understanding this population may be needed to better serve students of varying backgrounds and life situations (Kim, Sachs, Lee & Hagehorn, 2010). More recently, Bailey, Jaggars, & Jenkins (2015) published work with results that indicated a need for a complete restructuring of community colleges based on the looming negative results reform efforts have had.

Specific context: Maryland community colleges and policy. In a more recent statewide initiative, the Maryland Association of Community Colleges reacted to the consensus in the nation that improvement was needed with remedial coursework by adopting the College and Career Readiness and College Completion Act of 2013 (Fain, 2014). This act included goals for more collaboration between public K-12 schools with community colleges, increased data collection on readiness levels, and remedial course requirements to take place in the first 24 credits for first year students (Fain, 2014). Partly because of the requirements of this act, over 60% of students at one community college in Montgomery County, Maryland have required math remediation coursework

(George, 2015). "We have come to believe that having a high-stakes test is not the best way to measure someone's mathematical competency," said John Hamman, Dean of Mathematics and Statistics at Montgomery College. "Trying to look at a longer history of their work makes more sense than what they are able to do on one particular day" (George, 2015, p. 1).

Another initiative that occurred in Maryland stemming from the University System of Maryland was the Maryland Equity Project (Knepler, Klasik, & Sunderman, 2014). According to the Maryland Equity Project's policy brief from 2014, 58% of students in Maryland's community colleges were enrolled in at least one developmental course in 2007 (Complete College America, 2012). One of the key changes in policy for community colleges that stemmed from this project was a call for course redesign with less lecture time and more conceptual experiences and individualized work with students (Knepler et. al, 2014).

Review of Methodological Issues

Before delving into key methodological issues about developmental mathematics for community college students, it was important for the purposes of this study to consider recent findings about adult learning needs with a historical context. The work of Edward Lindeman during the 1920s helped set the stage for new understanding on how adults learn best, and has served as a strong means for analyzing the key issue at hand (Ozuah, 2016).

> The approach to adult learning will be via the root of problem solving, not subjects. I am conceiving adult education in terms of a new process by which the adult learns to become aware of, and to evaluate his experience. (Lindeman as cited by Ozuah, 2016, p. 83)

In other words, the component of self-reflection has historically been missing in the design of adult learning experiences. This was important to consider for this study because a learner's ability to self-reflect might directly impact one's mindset about a topic, as specified in recent research that

mindset changes the ability for students to access content they previously believed they could not grasp (Boaler, 2015).

Remedial program studies. It was found that states across the nation have varied in their policies regarding placement tests and programs for students who lacked readiness for college mathematics at their community colleges. Regardless of this variance, the unfortunate commonality of high rates of failure and attrition have led to a much research on remedial mathematics programs (Bettinger & Long, 2005). The state of North Carolina served as an all-encompassing example of statewide research since a comprehensive study of developmental programs was done across all 58 of their community colleges (Clodfelter, Muschkin & Vigdor, 2013). As previously discussed, one of two key conclusions drawn was that, "like several previous studies of remediation in community colleges, we find no evidence to support the idea that remedial education develops the academic skills of traditional-age students" (Clodfelter et. al, 2013, p. 371). Second, it was found that one of the central purposes of remedial education was its use as a diversion tactic to exclude needy students from enrollment in courses with students who not requiring extra help (Clodfelter et. al, 2013). This notion was also a key conclusion of a study done by Scott-Clayton and Rodriguez (2012) who added that the academic skills in question needed to be learned when students were still in high school. Like the study done in North Carolina, the general conclusion being found by researchers engaged in statewide studies was that students should be acquiring the missing skills prior to entry to college during their K-12 years, rather than action being taken via remedial coursework at the community college level.

In addition to conclusions found through statewide studies, two key bodies of research resulted in opposing views that embodied key factors in work done to analyze program effectiveness. That is, the work of Bailey et al. (2015) versus that of Boylan and Goudas (2012) showed disparate views on this issue and have served to epitomize the state of research on the

issue of remedial mathematics students. Bailey (2015) and his colleagues used a compilation of statewide data on failure rates to make the argument that overall developmental math programs have been historically ineffective and inconsistent from school to school, and state to state. Boylan & Goudas (2012) directly criticized this body of work with three key arguments. First, in the studies done by Bailey et al. (2015), developmental math was considered ineffective because it did not lead to better outcomes than student data on those who did not require remediation. Second, some studies with positive results were ignored, and third, overgeneralization occurred with no regard to the range of students based on cut-off scores (Bailey et al., 2013; Boylan & Goudas, 2012). In other words, Boylan & Goudas (2012) pointed out the possibility of serious flaws in the research, and that a closer look at remedial coursework and its effects should be examined, as well as the consideration of the many complexity factors faced by community college students. In that sense, the point was made that the effects of remediation were not as negligible as commonly believed.

Bailey, Jaggars, and Scott-Clayton (2013) have published a rebuttal to this idea stemming from Boylan and Goudas (2012) indicating high failure rates of remedial programs and a need for a complete restructuring and cost cutting measures. Their conclusions were largely based on quantitative studies that came from assessment data and attrition rates of students required to take developmental math (Bailey et. al, 2013). "The traditional system of assessment, placement, and developmental coursework has negative side effects (at the very least, it takes time and resources and may discourage students), which when considering the developmental population as a whole, tend to balance out its positive effects" (Bailey et. al, 2013, p. 18). In a recent quantitative study on the content being presented to remedial math students, it was concluded that the procedural skills being presented in remedial math courses did not transfer to the conceptual understandings required in college mathematics (Quarles & Davis, 2017). These results correlated with the

concept that the remedial programming itself was in need of a complete overhaul (Bailey, et. al, 2013).

Student characteristics and behaviors. Another theme found in the research on this issue stemmed again from the work of Bahr (2013) who has conducted multiple quantitative studies designed to analyze the effectiveness of remediation through the lens of student characteristics and behaviors. Over the course of the work, Bahr (2010) maintained that of those students who remediated successfully, there are comparable overall success rates with degree attainment as compared to students who did not participate in developmental programs. Another key factor tied to the success rate of students in need of developmental coursework was a high amount of collaboration with an advisor (Bahr, 2008).

On the other hand, looking through a demographic lens, it was found that among students in remediation a large success gap existed among black and Hispanic students when compared to white students (Bahr, 2010). However, of black and Hispanic students who remediated successfully, equal success rates occurred as compared to their white counterparts (Bahr, 2010). Contrarily, Gramling (2013) found that there were five key characteristics that predicted success at for-profit schools, which included being black. The other factors considered were high school grade point average, part-time enrollment status, taking fewer credits at a time, and expected family contribution for tuition. These findings may or may not have been related to students in community college, but were considered in this study as possible factors.

Over time, Bahr (2010) concluded that the analysis of success rates of remediation in math should be analyzed through the lens of enrollment behavior. Further, the author concluded that both pathways and outcomes, including duration of enrollment, needed to be considered (Bahr, 2013). "You cannot expect to understand racial and ethnic differences among students without reference to variation in students' pathways, decisions, course-taking behaviors, and enrollment

patterns" (Bahr, 2013, p. 141). Conclusions of Goenner, Harris, and Pauls (2013) aligned with Bahr (2013) about the need to study enrollment behaviors through the lens of persistence based on both ability and motivation. Upon studying behaviors of students prior to starting college, those who participated in college fairs, campus visits, and welcome weekends had higher persistence in college (Goenner et. al, 2013). Ultimately, it was found that with regard to researching student persistence, "motivation and ability both influence student outcomes; therefore failing to control for motivation incorporates a bias into the results, making it difficult to explain why students with similar abilities succeed in some cases and fail in others" (p. 60). Finally, another large quantitative study of 3,690 students served as a key example of methodology on this topic (Okimoto & Heck, 2014). Despite the large sample size, results regarding course redesign obtaining positive outcomes were unclear in terms of correlation since the improvement might have been influenced by teacher behavior, student behavior, or both (Okimoto & Heck, 2014). A higher level of engagement may have been the ultimate reason since, "students who are actively engaged in the learning process may have a greater likelihood of success" (Tinto as cited by Okomoto & Heck, 2014, p. 645). Overall, the body of literature about student characteristics and behaviors has been centered on demographics, enrollment behaviors, and levels of motivation.

Student beliefs. There were noteworthy findings in the literature regarding student beliefs which included strong views about what learning mathematics means, as well as the perception of what is meant by being placed in remedial math upon entering college. In terms of views about learning mathematics, a qualitative study in which developmental math students were given problems to solve and explain showed an overwhelming propensity for students to approach math in a very procedural and disconnected way (Givvin, Stigler, & Thompson, 2011). Students lacked number sense and attempted to recall rules they had been shown in the past (Givvin, et al., 2011). Conversely, Bachman (2013) conducted qualitative research that revealed the student perception of

being placed into remedial math as a psychological factor that had to be faced in order for increased student success to occur. In this study, it was found that students perceived the need for remedial math to mean they were "dumb" and there was a great deal of surprise, since many of the students had done well in high school mathematics courses. Many of the existing quantitative studies made mention of the factor of perception as one of the key reasons remedial mathematics might be considered a barrier for many students (Bailey et. al, 2013; Clodfelter et. al, 2015).

Based on the research of Yeager and Dweck (2012) strong conclusions were reached that showed when students were convinced they were able to develop new personal characteristics, they attained higher levels of success with developmental coursework. "Growth mindset interventions convey that intelligence can grow when students work hard on challenging tasks—and thus that struggle is an opportunity for growth, not a sign that a student is incapable of learning" **(**Paunesku, Walton, Romero, Smith, Yeager, & Dweck, 2015, p 2.). According to a quantitative study conducted by Muis & Duffy (2013), students who were given a treatment of discussion in which new beliefs and strategies were explicitly discussed achieved more success with remediation than those who were only given the remedial instruction. This innovative approach to intervention can be directly tied to adult learning theory since it can be inferred that much of what students in need of remediation are missing is the ability to reflect on their own learning, to be self-driven, and to connect new learning to prior experience (Kimball & Smith, 2013).

Synthesis of Research Findings

As previously laid out in this chapter, mostly quantitative research has been conducted on programs, student demographics, student enrollment behaviors, and student perceptions. Overall, programs appeared largely ineffective for most students in need of remediation. In February of

2016, the American Association of Community Colleges released a report containing this statement from Matt Gandal, the organizer of the Higher Ed for Higher Standards coalition:

> We have a preparation gap in this country that's leaving too many young people unprepared when they arrive in community college. Community colleges have an opportunity to close this gap by working together with their K-12 counterparts to adopt proven strategies that are getting real results for students. It all starts with high expectations. (AACC, 2016, p.1)

While this statement is a call for action in terms of increased partnerships with K-12 education and increasing expectations, it does not mention the learning or the current community college learners' needs.

Research findings on unprepared mathematics students. Bettinger & Long (2008) stated that only students on the margin of needing remediation have shown high levels of success. Further, some studies have indicated that just the notion of having to take a remedial course can negatively impact a student's chances of obtaining their degree (Perin, 2011). Bailey (2009) posited that not enough work has been done to discover the exact differences between students who need to take developmental math and those who do not. The need for math remediation varies from student to student, and many variables influence the outcome. Thus, some studies have attempted to discern between students in terms of how great a need for remediation exists. For example, in what was termed a quasi-experimental design, Rodgers, Posler and Trible (2011) attempted to expedite the remediation process in which a three-week Rapid Review program showed positive results for an experimental group. Rodgers et al. (2011) held the conclusion that for some students, a three-week intendsive review could replace an entire semester of remedial math. Results of studies such as this one have indicated that a wider variety of remediation choices may be needed regarding college preparedness. Once again, a review of available literature has shown no conclusive solution in terms of what type of programs have worked for

various types of students consistently. As another example, researchers of a study on the validity of placement exams for remediation concluded that there was a strong need for changed practices, but what those changes would entail remained unknown (Hughes & Scott-Clayton, 2011). This was also demonstrated through research results of a quantitative study done on 28,000 students in Maine that indicated placement scores were causing high numbers of high school graduates to be enrolled in math courses well below the level of the courses taken in high school (Hoyt & Sorensen, 2001). This combination of studies might indicate an over-reliance on placement scores or a need for different levels of assessments.

Connecting to adult learning theories. The more successful remediation programs at community colleges seemed to have included metacognitive aspects, rather than a sole focus on content (Garcia, 2003). This finding supported the notion that adult learning theory be considered when the needs of learners in need of developmental math in college were investigated rather than content ability alone. In other words, a better definition of college preparedness related to student learning habits/behaviors has been shown to be needed in order uncover more of the issue (Barnes, Slate, & Rojas-LeBouef, 2010). As an example, a study whose researchers indicated a need to merge the idea of content readiness and student learner behaviors found a direct correlation between course success and observable student behaviors such as self-regulation, active participation in class, and completion of homework (Li, Zelenka, Buonaguidi, Beckman, Casillas, Crouse & Robbins, 2013). In another study in which data was collected on 400 community college students, it was indicated through student surveys that there was a strong correlation between success in developmental math and the students' sense of self-efficacy (Zientek, Yetkiner, Fong, & Griffin, 2013). Finally, a longitudinal study where 718 new community college students were surveyed during a year resulted in positive indications that active learning in the classroom was a contributing factor to success, as well as decreasing student departure from college

(Braxton, Milem, & Sullivan (2000). Studies such as these aligned with the theories of Knowles (1980), Tinto (1975), and Mezirow (1991) since the concepts behind adult learning cannot be extracted from content knowledge acquisition. In other words, if students have been given the skills to study and learn for themselves, perhaps they could have developed a sense of independence leading to success in their coursework. In terms of mathematics, the conclusions made from the body of literature indicated that students may need to be given opportunities in which they must think for themselves as opposed to being given explicit procedures that permeate American mathematics education at any level (Stigler et. al, 2010).

The ASHE Higher Education Report defined student success in terms of "academic achievement, engagement in educationally purposeful activities, satisfaction, acquisition of desired knowledge, persistence, and attainment of educational objectives" (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2011, p. 10). While these criteria were strongly aligned with prominent adult learning theories, the report also pointed out how slow higher education institutions have been in terms of their willingness to change from traditional practices to ones that were better aligned with students in need of remediation (Kuh et al., 2011). In her compilation of several studies, Garvin (2012) indicated a need for stronger mentoring and advising of students rather than isolated developmental courses, a conclusion which again supported a possible connection that the use of adult learning theories may be an important missing link to bolster efforts of reform.

Clearly the issue of unprepared students in mathematics is complex. Since community colleges remain a key gateway for students of diverse backgrounds to access a higher education, it has remained the responsibility of these institutions to implement policies that directly related to the learners themselves (Flaherty, 2017). Adelman (2005) has defined the state of remediation as a burial ground for one's higher education rather than a gateway, thus perhaps it is through the lens

of adult learning theory that the needed change might be spurred. "Math should be a gateway, not a gatekeeper, to a successful college education….They need to think, I can understand this, I can do this, this is important to know" (Bryck & Treisman, 2010, p. 32). The overarching theme found in the research on this matter is that institutional educators cannot simply look at mathematics curriculum and content itself, but rather, the students and their adult learner behaviors. Key findings across the body of research included the idea that different levels of remediation have long been needed, with many students involved who have struggled with mathematics content alongside a lack of self-regulating learner behavior skills (Bailey, Jeong & Cho, 2010; Hodara & Jaggars, 2014).

Critique of Previous Research

There have been many summaries of quantitative research completed which centered on the occurrence of high numbers of unprepared students entering community college. The topic has been thoroughly examined through the perspective of higher education institution program designers, governmental bodies, and educational scholars. Most researchers on the topic have concluded that developmental mathematics coursework is largely ineffective (Bahr, 2013; Bailey, Jaggars, & Jenkins, 2015; Bettinger & Long, 2008; Cox, 2015). As previously stated, one prominent theory indicated a continued need for better partnerships between K-12 education and higher education in order to decrease the number of students entering college who need remediation (University System of Maryland, 2015). According to Bailey, Jeong & Cho (2010), another key finding from several studies was that a disproportionate number of students enrolled in developmental coursework were black, were enrolled part-time, and/or were vocational students. Still other work has pointed to a need for changed policy in terms of teaching practices and specified course sequences with increased student advising for all populations enrolled in remediation for mathematics (Garvin, 2012). In short, while results of studies have shown there

are diverse needs among remedial students, there has been no indication on what might be done to improve identification of student needs.

Despite the amount of information gleaned from the research, very little can be found in terms of understanding the problem from the perspective of the students. Further, there has been a lack of information on types of programs available for students in terms of the needs of adult learners. For example, much of math instruction in American higher education institutions has consisted of lecture-style sharing of rules and procedures in mathematics, which has been found to be in opposition to the well-documented work of scholars such as Lindeman (1926), Knowles (1993), Burns (1998), and Boaler (2016). The leaders of the National Council on Teaching Mathematics (NCTM) and many other math education scholars have been recommending a more conceptual approach to mathematics than has been utilized for decades. Furthermore, since the traditional lecture type of instruction clearly did not work for many high school graduates, it is unlikely these same practices would be effective for students enrolled in remedial mathematics in college (Stigler, Givvin, & Thompson, 2010). In their review of the accumulation of research on this topic, Parmer & Cutler (2007) pointed out that overall, researchers have failed to study what specific practices work with remedial students and which do not.

Conversely, some preliminary studies on increasing explicit instruction with students regarding belief has shown some positive results, but it is unknown if this would be true for all students from all populations (Boaler, 2013). Adult learning theorists have suggested that students need time to consider how new learning connects with what they already know (Knowles, Holton, Elwood, & Swanson, 2012). It was also suggested there is a need for time to compare previous understanding of concepts with newly acquired understanding (Mezirow, 2000). Stated another way, much of adult learning rests on the concept of reflection and self-regulation (Metz, 2005; Mezirow, 2000). Perhaps in addition to being told that ability and intelligence are indeed

malleable, remedial students have also needed explicit instruction on how to engage in metacognition, or thinking about one's own thinking (Kimball & Smith, 2013). "In many ways a learner's awareness and insight about development of his or her own mind is the ultimate and most powerful objective of education; not just thinking, but thinking about our own thinking" (Zull, 2011, p. 259). However, since very little research has been done with remedial students in terms of their behaviors, habits, and backgrounds as learners in connection with the acquisition of mathematics knowledge, these statements about metacognition and reflection may or may not be impactful. Therefore, a key critique of the body of research available is that most researchers have not generated clear solutions to this issue that directly link to adult learning theory based on the experiences of the learners themselves, nor have they answered why certain new course designs succeed while others fail (Okimoto & Heck, 2014).

Rather than continue to quote statistics about failed efforts of remedial programs in community colleges, perhaps more information about student characteristics, qualities and perceptions that have influenced their learning of mathematics should be gathered. A very telling conclusion based on the large body of work by Bahr (2013) indicated that his conclusions based on quantitative data may not be sufficient for understanding students in remediation.

> However, this type of research cannot answer with any certainty why students exhibit the behaviors that they do…. Why do students who have passed all remedial courses to date drop out of the remedial sequence after a single non-passing grade, while continuing to attend college and take other courses? Answering questions of this type-the why questions-is no less important than is answering the how questions, but it will require a different approach, specifically a qualitatively oriented approach. (Bahr, 2013, p. 148)

In essence, what Bahr (2013) expressed was that while researchers have gathered a large collection of quantitative data about community college students and course offerings, no one has gotten to

the root causes of the phenomenon. The limitations of quantitative research on this topic might be the result of the collection of extensive amounts of statistics that lack pertinent details about the unique characteristics of students, a needed component for improvement of remedial mathematics programs nationwide (Bailey et al., 2013).

Summary

"The bottom line….is that remediation in higher education is not some monolithic plague that can be cured by a single prescription" (Adelman as cited in Attewell, Lavin, Domina, & Levey, 2006, p. 889). As has been discussed, the research available to study was largely quantitative and generally indicated that community college remedial programs do not work for most students who need them (Bailey et. al, 2013). Various researchers have indicated a need for different types of instruction, increased advising, and a need to understand the community college student as unique compared to students at four-year institutions (Bailey & Jaggars, 2016). Bettinger & Long (2005) pointed out that despite the controversy surrounding this topic, when students of the same backgrounds and needs are compared, those that participate in remediation have a much higher success rate in college. Rodgers, Posler, and Trible (2011) found that some students succeeded more readily when remediation efforts were accelerated. Further, Bahr (2013) also made a case for consideration within the group of community college students in need of remediation and has posited that institutions could succeed with this population if more consideration was given to individual goals. For example, the mathematics needs of someone pursuing a vocational certificate should differ from someone pursuing a degree in a STEM (Science, Technology, Engineering, and Mathematics) field (Bahr, 2013). Garvin's (2012) synopsis of studies aligns well with this premise since she recommended that more advising, mentoring, as well as course alignment occur rather than allowing students to randomly sign up for courses on their own. An additional prominent factor was that "supporters of college remediation

draw attention to the fact that students of color, students from less affluent families, and students for whom English is a second language are greatly overrepresented in remedial courses" (Attewell et. al, 2006, p. 886). The conversation about this disparity among learners has continued to be debated despite the extensive amount of literature.

More student-focused research is needed so that personal backgrounds, perceptions, behaviors, beliefs, and habits can be understood in a way that could support changes, such as a more diverse set of programs to meet their varied needs. With community college students in particular, a range of learning preferences and life situations may exist that are different from students who attend four-year colleges. As mentioned previously, andragogy as described by Knowles (1980) in terms of student characteristics including their motivation and orientation towards learning may be key. For example, in a study done in an urban community college, increased retention of students occurred in two different programs offered there when an increased focus on the connection between the programs and a career were established (Nitecki, 2011). Clearly "the art of teaching adults effectively requires an understanding of various principles or theories of how adults learn, and requires making an effort to apply some of those principles to practice" (Corely, 2012, p. 1). Unique adult learners deserve to have a voice in how their education is approached to open a pathway to their understanding of mathematics, as well as their future success as productive citizens of American society. Therefore for this study, it was determined to conduct much-needed research in which students were given the opportunity to discuss themselves as learners of mathematics. Based on the review of research, and the consideration of adult learning as a framework, it was key to design a study with the goal of discovering new information about the lived experience of students enrolled in math remediation as a means to contribute their voices to the existing literature.

Chapter 3: Methodology

Introduction

As indicated in the review of literature, directly in the path to a higher education is a barrier for many students in the form of math remediation requirements prior to enrollment in credit-bearing coursework. "Over 70% of community college students are reported to be inadequately prepared for college mathematics" (Okimoto & Heck, 2015, p. 633). This barrier has been steeped in complexity because of many contributing factors, including institutional policies that vary from state to state. Regardless of the various reform efforts that have been tried over the years, thousands of students each year have been required to take remedial mathematics courses upon entry to college.

Specific to the area of mathematics, colleges enroll "more than 1.5 million students who are identified as unprepared to succeed in college-level mathematics" each year (Chingos, M. M., Griffiths, R. J., & Mulhern, 2017, p. 1). While the purpose of developmental courses is to equip students with the skills they will need to pass credit bearing coursework in mathematics, some evidence from research supports the notion that enrollment in such courses can be correlated with failure to graduate from college (Bailey & Jaggars, 2015; Calcagno, Crosta, Bailey, & Jenkins, 2017). Though there are various factors that may contribute to a student's lack of persistence through a college program, the structure of developmental coursework and the frustration involved in having to enroll in them has been linked to high rates of student attrition (Chingos, et al., 2017; Complete College America, 2011). This issue is one of great significance to countless high school graduates entering college, and is impactful to American society at large since we are now living in a "time when three-quarters of the fastest growing occupations require post-secondary education," yet "our college participation rates have slipped from 1st to 16th, and only about a third of our young people receive a college degree" (Darling-Hammond, 2015, p. 3).

Clearly the substantial number of students who fail to get through the requirement of developmental mathematics upon entering college is a significant problem and worthy of further study (Bracco, Austin, Bugler, & Finkelstein, 2015). "To address the challenge of large numbers of students being placed into developmental education and not enough moving on and succeeding in subsequent credit-bearing courses, several of the Core to College states have undertaken statewide efforts to redesign their developmental education programs" (Bracco, Austin, Bugler, & Finkelstein, 2015, p. 2). Core to College was a Gates Foundation grant that includes 12 states (Bracco et. al, 2015). Examples of states involved in this effort include Colorado and North Carolina, but the crux of the work has involved faculty and institutional leaders, not the students (Bracco et. al, 2015). However, based on a decade of research focused on improving remedial coursework, "far too often, a wide gap exists between what the profession believes it should be able to accomplish and what actually occurs" (Bryk, Gomez, Grunow & LeMahieu, 2015, p. 59). Thus, it was posited for the purposes of this study that not enough researchers have focused on finding out about the student perspective about remedial mathematics coursework. The goal of this study was to assemble information about students enrolled in remedial mathematics from the student point of view. In doing so, I attempted to discover pertinent information about them that could lead to the improvement of math remediation course sequences at community colleges in terms of student learning needs.

As a means to analyze and interpret data gathered on this topic, a conceptual framework of adult learning theory alongside current research regarding the influence of mindset served as a primary lens to direct this phenomenological analysis. Adult learning theory has been linked with mindset based on the growing body of research whose results indicate that explicit work with students on developing a growth mindset, meaning the belief that they can in fact learn math, has increased student achievement in math (Boaler, 2015; Dweck, 2016). The development of a

growth mindset correlates well to the qualities of adult learners as discussed by prominent theorists since many of those characteristics are tied to belief and reflection on one's own learning. Specifically, ideas from adult learning theories were utilized to conduct a deep analysis of themes arising from my research in terms of important learner qualities such as self-monitoring, reflection, motivation, and persistence (Knowles, 1980; Mezirow, 1991; Tinto, 1975). Tinto (1975) viewed the college student in terms of motivation, persistence, and self-efficacy. In fact, there has been a recent shift away from traditional pedagogical practices in secondary education with the implementation of the Common Core Standards in 2009 in 48 states (Common Core State Standards Initiative, 2017). To clarify, pedagogy has been traditionally defined as teacher-centered instruction, whereas andragogy utilizes strategies that are student-centered (Pew, 2007). The onset of the Common Core Standards has called for increased inquiry-based instruction with a focus on conceptual understanding and independence as learners as well as focusing on creating a community of collaborative problem solvers (Common Core State Standards Initiative, 2017; National Council of Teachers of Mathematics, 2014).

The way in which educators design their delivery of instruction has changed over time based on the concept of students coming to school well-versed in technology as compared to their teachers (Prensky, 2012). More recently, Bullen (2016) as well as Holland (2017) have reshaped Prensky's theory on digital natives to point out that all learners, regardless of age, should now be considered digital learners. Based on the premise that learners have changed due in part to the infusion of technology, it may be that the characteristics of today's learners are more aligned with ideas from adult learning theorists. Thus, it was determined that the ideas traditionally considered adult learning characteristics could serve as a lens when interpreting participant's stories about their learning of mathematics. The six key elements from Knowles (1980) including self-concept, experience, readiness to learn, orientation to learn, motivation to learn, and the need to know were

components to consider. In fact, "Knowles himself eventually revised his own assumptions, observing that following his 1970 book…practitioners in the field of elementary and secondary education identified that students responded well to the andragogical model" (Aubrey & Riley, 2016, p. 94). Furthermore, it was determined that andragogy as defined by Knowles (1970) meshed well with current brain research specific to the area of mathematics in terms of the concept of how one's mindset directly affects one's ability to learn (Boaler, 2016; Yeager & Dweck, 2012). These prominent researchers have suggested a need for students who have traditionally struggled with mathematics to be explicitly taught to change their mindset, which connects their work to the adult learning theory of Mezirow (1991) in terms of transformation through critical reflection. In addition, when the perspective on this topic is broadened to include sociology, critical theory, and even feminist perspective, one might also consider that the idea of mindset links to the concept of equity of access to learning (Alhassan, 2012).

In this study, a blend of adult learning theories based on the recent shifts in thought that andragogical practices were appropriate for a wider range of students than previously believed was considered (Knowles, Holton, Elwood, & Swanson, 2005). This was a means to discover themes concerning participant learning needs, motivation, mindset, and possibly other factors not anticipated. Precedent for viewing students from the psycho-social aspects of andragogy aside from Tinto (1975) have been established in other studies such as that of Fong, Davis, Kim, Kim, Marriott, and Kim (2016) and Chen and Starobin (2017). A combination of adult learning theories alongside current research on the impact of mindset on learning was used. This blended conceptual framework served as a means to analyze student perceptions about themselves and allowed me to discern between elements of academic preparedness versus the more psychologically based idea of college readiness.

Research Question

In methods courses for teacher preparation programs, it is typical for instructors to engage students in a reflection of their own learning on a subject during their years in school termed an "autobiography as a learner" as a means to consider what pedagogical practices they believe were effective with them and which were not. Using this idea, participants were engaged to discuss themselves as learners of mathematics with the addition of several guiding questions to assist them with telling their stories as math learners over the course of their education.

Core Question: What is the lived experience of students who have been enrolled in remedial coursework in community college in terms of their history as learners of mathematics?

To obtain in-depth answers to the research question, the following sub-questions were used to guide the use of clarifying questions during the interviewing process:

- What themes emerge when participants describe their history as a learner of mathematics?
- How do participants describe any change throughout their years as math students with regard to their personal characteristics, learning preferences, or needs?
- What do participants reveal about their overall mindset about learning mathematics in connection with being placed in a remedial math course at the community college?

Purpose and Design of the Study

The purpose of this study was to discover if there were common characteristics and experiences among students required to take remedial math coursework that might lead to developing proactive practices designed to improve the likelihood of their success. For example, it was possible these students held a negative mindset, as discussed by researchers such as Boaler (2016) and Dweck (2008), that affected their attitude and perception about their ability to learn

mathematics. It was a key element of the study to discern perception about their responsibility versus their educational programs by finding out their characteristics as they pertained to the work of Tinto (1975), Knowles (1980), and Mezirow (1991).

Based on the goal to discover key themes about the lived experiences of remedial math students, it followed that a phenomenological study be designed to glean information directly from those experiencing such coursework. "The first thing we must do, and first of all in immediate reflective self-experience, is to take the conscious life, completely without prejudice, just as what it quite immediately gives itself, as itself, to be" (Husserl, 1970, p. 115). Specifically, the design was a form of descriptive phenomenology in which students experiencing the phenomenon were given an opportunity to tell their stories as learners of mathematics in order to uncover ideas that could lead to improvement of developmental coursework for adult learners. As stated previously, most students enrolled in remedial coursework at community colleges have not persisted to complete a degree or certificate (Bailey, Jaggars, & Jenkins, 2015). Many stakeholders have made conclusions that developmental math course sequences have been largely ineffective, and in fact may have impacted student persistence negatively (Bahr, 2013; Bailey et. al, 2015; Martorell & McFarlin, 2011). According to Goudas and Boylan (2012), the results of research on remedial instruction have been largely inconclusive. Furthermore, it was pointed out by Davidson and Wilson (2016) in their summation of community college attrition, that the community college students themselves are essentially different from those entering four-year institutions. However, few studies have delved into the past experiences, perceptions, and motivations of these students to better understand who they are.

According to Creswell, (2013) phenomenology "is an attempt to approach a lived experience with a sense of 'newness' to elicit rich and descriptive data" (p. 331). Using an open-ended interview in which students were prompted to share their backgrounds in the area of

mathematics, was utilized to gain new insight about the shared characteristics of students taking remedial mathematics. The design of the study allowed for the discovery of new information about the phenomenon from students currently experiencing it. Students were asked to describe their perception of their background in mathematics, which allowed for an increased understanding of why such students are statistically at-risk for failure to pass the remedial coursework or to persist through college. In this case, the facts studied were the experiences, perceptions, and opinions of students who found themselves in need of remediation at the beginning of their college career. "A phenomenological researcher is interested in describing a person's experience in the way he or she experiences it, and not from some theoretical standpoint" (Bevan, 2014, p. 136).

Research Population and Sampling Method

The research population came from several sections of developmental math courses at a community college in the mid-Atlantic region. A form of non-probability sampling known as convenience sampling was used to recruit participants. The population was narrowed to students who graduated from high school within the last five to eight years. This amount of time allowed for participants who had enrolled just after high school graduation, or who had chosen to work or join the military for a few years. It was determined not to include students who had signed up for remedial math by choice as a refresher due to being out of school for a longer period of time.

With permission from the research site institution and course instructors, it was announced to several classes the intention to conduct a study and go over key details found in the Consent Form to clarify details, particularly regarding protection of privacy. After giving a short talk introducing myself as the researcher and the purpose of the study, interested parties provided their e-mail address for the purpose of scheduling an interview. Using this method over the course of two semesters, 13 participants were recruited: six who had completed a course and seven who were enrolled during the time of their interview.

Instrumentation

Instrumentation for the proposed study included an interview protocol designed to allow participants to tell their story as math learners. Once recruited, participants from several sections of the remedial courses offered at the community college were scheduled to meet in a quiet area available on campus. A script was utilized (see Appendix A) for both the beginning and end of the interview to ensure that the purpose of the research was explained, and that the use of a recording device was only to be used for analysis for the study (Jacob & Furgerson, 2012). When instances occurred in which participants were unsure about what to share, the prepared bank of questions was used to elicit more detail. Additionally, a few brief questions were asked at the end of the interviews regarding demographics since it was possible that socio-economic status and race may have been found to be influential factors. A one-hour segment was scheduled for each participant with time for bracketing initial reflections and reactions between interviews.

> In his analysis of instrumentation for qualitative research, Chenail (2011) suggested that: when performing as a discovery-oriented research instrument, qualitative researchers tend to construct study-specific sets of questions that are open-ended in nature so the investigators provide openings through which interviewees can contribute their insiders' perspectives with little or no limitations imposed by more closed-ended questions. (p. 255)

Jacob and Furgerson (2012) have also suggested that the interview design be based on a series of open-ended questions formulated from previous research on the topic. However, prior to officially beginning the study, three pilot interviews were conducted which caused me to create one extra question that gleaned much information by prompting participants to make recommendations for possible changes to the remedial coursework in the future.

Throughout the interview process, active listening was employed which resulted in clarifying questions and probing that was only present in skeletal form in the originally planned

interview (Benner as cited by Bevan, 2014). "Emergent design (Creswell, 2007) is one of the hallmarks of qualitative research and sticking to your interview protocol exactly does not allow for the design to emerge naturally as you conduct research" (Jacob & Furgerson, 2012, p. 5). Consquently, in addition to open-ended questions there was flexibility to the interviews despite its preplanned structure so that each participant had the opportunity to fully unpack their story.

Data Collection

The data collection process was planned and executed in a way so that the data analysis was considered "part of a single, unified process with the same underlying theory of science" (Englander, 2012, p. 15). During the interviews, notes were taken by hand while simultaneously audio recording the sessions (with student permission). The recording document originally planned to be used with a column for moment-to-moment bracketing was not effective during the interviews, but proved useful during the transcription of the recordings (see Appendix B). This method of data collection while transcribing allowed for the consideration of the relationship between researcher, topic, and the sense-making process as described by Creswell & Miller (2000). Despite not having time to bracket during the interviews, there was time to write in my reflexive journal between interviews, and the notes taken during the interviews could be expanded upon immediately afterward.

Identification of Attributes

One important attribute to qualitative research is the idea of generating a hypothesis versus working to prove or disprove one. In other words, the research questions require an explanation versus a definitive yes or no answer (Sullivan & Sargeant, 2011). In this case, several key attributes were present based on my intent of generating a theory on how the issue might be rectified. Roller and Lavrakas (2015) identified 10 key attributes of qualitative research, of which I have conceptualized this study with four. First, as with all qualitative research, was

acknowledged there was an absence of absolute truth, meaning the participants told their stories based on their perceptions (Roller & Lavrakas, 2015). Specifically, information was gathered through storytelling since the interview questions were purposefully minimal and open-ended, and required participants to tell their life story as math learners. This idea was directly tied to a second attribute, identified as the importance of context (Roller & Lavrakas, 2015). Relying on thick and rich description, it was important to gather as much detail as possible about the context through which the participants were speaking.

The third attribute known as participant-researcher relationship was important in the sense that the participants needed to be made comfortable, without imposing personal opinions or personal feelings about their enrollment in remedial mathematics or about the institution's policies and practices (Roller & Lavrakas, 2015). As a math educator for nearly 20 years with a vested interest in working towards improvement of math education in general, the interviews were conducted with a strong interest in the teaching practices the participants had experienced, but it was important not to indicate any personal teaching philosophy or opinions to them. Finally, the fourth attribute which has been referred to in research as "messy analysis" was present described by Roller & Lavrakas (2015) as such:

> It is the data that inform the qualitative analyst in the development of codes and categories, and it is the data that determine the connections that are made (or not made) between various points of information, as well as the meaningfulness of these connections in conjunction with the research issue or phenomenon. (p. 8)

To be clear, a multi-layered topic was analyzed without the constraint of looking for linear connections. Rather, the information gathered was interconnected into a web-like formation with key categories anticipated, including but not limited to teaching style, learning style, student-

teacher relationships, curriculum type, beliefs about mathematics, and mindset about natural ability versus hard work and practice.

Data Analysis Procedures

Wilding and Whiteford pointed out in 2005, "The ordinariness of the phenomenon must be looked at with critical eyes so that a different truth can emerge. In this respect, phenomenological processes have been likened to the creative processes of an artist" (p. 99). For this study, the analysis was planned to be structured less like an artist and more like a scientist in the sense that to understand different truths, a methodical sequence of coding was needed. As described in the introduction, the conceptual framework of andragogy (adult learning theory) was employed to analyze responses according the aforementioned key characteristics of adult learners which included background, readiness, problem-solving, intrinsic versus extrinsic, and goal orientation (Knowles, 1980; Tinto, 1975). These traits have been considered indicators of persistence as well as the ability to reflect on oneself as a learner (Mezirow, 1990; Tinto, 1987). Additionally, responses were analyzed in terms of belief about learning itself and the malleability of intelligence as connected to the work of Yeager and Dweck (2012).

The sequence of coding was trifold. First, once transcribed from the audio recording, student narratives were looked at through open coding. Transcripts of the recordings coupled with the written notes taken during the interviews were broken down "into first level concepts, or master headings, and second-level categories, or subheadings" (Biddix, 2009, p. 1). Examples of broad categories that were considered in the planning of this study were negative attitudes about math, family background, and student anxiety (See Appendix B). Next, the student narrative transcripts were revisited using axial coding, a way to look at the information using predetermined categories (Biddix, 2009). The prescribed categories were later altered based on the open-coding process. The third step was to organize the two levels of coding into a mind map in which major

categories were determined and linked to all the associated sub-categories (Biddix, 2009). Once these three major steps were taken, deep analysis of the information gathered was possible.

Because the research questions lent themselves to dual interpretation, specifically how the subjects made sense of the phenomenon, and how their responses allowed me to make sense of it, Interpretative Phenomenological Analysis (IPA) was used, which is a stance that goes beyond basic descriptive analysis (Larkin, Watts, & Clifton, 2006). IPA aligned with my vision for this study because it was a way of looking a qualitative data without the use of previously found theories on the topic (Smith, 2017). "Indeed, it may be more appropriate to understand IPA as a 'stance' or perspective from which to approach the task of qualitative data analysis, rather than as a distinct 'method'" (Larkin, et. al, 2006, p. 104). In other words, with IPA, I attempted to get as close as possible to the participant point of view, and worked to develop a new interpretation of their perceptions as I attempted to "make sense of the participants trying to make sense of their world" (Smith & Osborn, 2015, p. 26). The rationale for this form of analysis was based on the results of current research on difficulties with mathematics which has revealed the psychological aspects of mindset and belief as key factors, versus lack of ability to learn mathematics (Boaler, 2013; Ramirez, Gunderson, Levine, & Beilock, 2013; Yeager & Dweck, 2012).

The sense-making the subjects made about the phenomenon allowed me to discern more about this topic in terms of the psychological factors of belief, opinion, or history of anxiety, as well as the habits and history involving mathematics content. Further, as Larkin, et al. (2006) pointed out, it was important to have "recognition that it is not actually possible even if it might be desirable to remove ourselves, our thoughts and our meaning systems from the world, in order to find out how things 'really are' in some definitive sense" (p. 106). As a result, no personal commentary was included in data collection of student responses. Participants were listened to and only asked to clarify what they meant using the set of guiding questions as needed. Prior to the

study, the guiding interview questions were utilized in the pilot study to ensure they were designed to elicit sufficient detail from participants. Once the data were collected, continued reflexive journaling was used to note opinions or ideas about responses to participant narratives. Again, this was a means of bracketing off any preconceptions, which allowed for interpretative analysis with a high level of objectivity.

Limitations and Delimitations of the Research Design

As with any qualitative study, it is important to recognize both what one intends to accomplish and what one does not (Simon & Goes, 2013). This study was based on a topic that was complex and rich with history and debate, including many different stakeholders. The phenomenon of the high number of students required to take remedial mathematics could be studied from the viewpoint of higher education policy makers, K-12 policy makers, higher education teachers, students, curriculum designers, or even companies with shortages of employees with mathematics problem solving skills. The issue might also be framed from a philosophical viewpoint with consideration of educational theory such as the debate between constructivism versus behaviorism, or recent developments in educational brain research. In the case of this study, the viewpoint of students enrolled in remedial mathematics who had graduated from high school within the last five to eight years was gathered and analyzed.

Limitations. Naturally, there were limitations to the study since it was designed to center on the subjects' depiction of a lived experience through the medium of an interview as the instrument. This choice in methodology narrowed the study to a small sample size in a specific setting (Simon & Goes, 2013). Specific to the participants, the students interviewed had the unique characteristic of having obtained their K-12 education during a time period when states had shifted away from their own adopted curricula and took on the Common Core Standards as part of an effort to nationalize curriculum. Considering the well-known controversy regarding the

implementation of the national curriculum, as students were asked to express themselves about their experiences with math, some of their comments may have stemmed from negative perceptions about how mathematics instruction had changed, possibly being shaped from colleagues, parents, or the media. Another limitation to consider stems from the recruitment strategy for gathering participants. There could be aspects about students different from those who readily volunteered their time with me that cannot be known from this study.

Delimitations. This study was designed to allow exploration of the issue from the student perspective. Specifically, the pool of participants was narrowed to students who had graduated from high school within the last five years to eight years. As an educator who has studied best practices in mathematics education from Kindergarten through higher education, I wanted to be able to consider where the breakdown was occurring since as previously mentioned, thousands of students exiting high school each year end up qualifying for remediation. Limiting the study to fairly recent graduates was a way to keep the study focused and manageable since opening it to older students returning to school after many years would broaden the issue in terms of various life and career experiences. In addition, a delimitation was set to exclude students who received official Special Education services. My rationale for this was that some Special Education students were placed in remedial mathematics courses with the intent of preparing them for life skills in alternative programs, and were not part of the general population for which the literature review was completed. A goal of this study was to discover more about the characteristics of students who had graduated having met high school mathematics requirements, who qualified for math remediation, but who were not on an alternative track due to special needs.

Validation

To establish validity, methods described by Creswell & Miller (2000) were used. They discuss the concept of viewing data collected in a study from different lenses, including that of the researcher. Reflexivity was used, meaning to "self-disclose assumptions, beliefs and biases" (Creswell & Miller, 2000, p. 127). The reflexive journal kept throughout the process was a means to continually check the analysis for objectivity, and was used as part of discussions with identified colleagues employed to assist with this. "This validity procedure uses the lens of the research but is clearly positional within the critical paradigm where individuals reflect on the social, cultural, and historical forces that shape their interpretation" (Creswell & Miller, 2000, p. 127). Two educational colleagues reviewed the analysis external to this study, which was one means of establishing validity known as peer debriefing (Creswell & Miller, 2000). Through their viewpoints, it was ensured that claims were backed up with compelling evidence, and that overall the depiction of the results made sense.

Credibility. To ensure credibility of the study, the use of thick, rich description was used so that readers of the study would be able to visualize what it might be like to experience the phenomenon themselves (Creswell & Miller, 2000). "Thick description refers to the detailed account of field experiences in which the researcher makes explicit the patterns of cultural and social relationships and puts them in context" (Holloway, 1997). In conjunction with being able to construct a vivid narrative without personal opinions or biases throughout the study, the reflexive journal previously discussed allowed for the bracketing of opinions, beliefs, and background on the topic of mathematics education. "Therefore, the ability to be aware of one's own values, interests, perceptions and thoughts becomes a prerequisite before we can set aside the things that influence the research process" (Chan, et. al, 2013, p. 3). This process allowed for the construction of meaning from the information collected separate from a personal background on the topic, as the

data were coded in order to create a description of the phenomenon as experienced by the participants (Creswell & Miller, 2000).

Dependability. To establish a means to determine dependability, a consistent procedure and structure was used while keeping extensive records of the process. While the interview was open-ended in terms of allowing participants to share a narrative likened to an autobiography, a bank of questions was used as needed when participants were not forthcoming with rich detail. Prior to the official study, the bank of questions was tested to ensure that the questions were effective. This pilot study prompted revision of questions so they were focused on the information desired. This was also an opportunity to check that the follow-up questions regarding demographics were phrased in a sensitive way.

During the interview process, both note-taking and a recording device were used to ensure accuracy of the information being collected. This consistency allowed accuracy with each interview so as to create meaning from themes that emerged. "We can move from making observations about the details of talk, to developing an analysis of a conversational phenomenon or practice---in other words, arriving at findings about stable and systematics patterns in talk" (Drew, 2007, p. 157). It has been suggested by many researchers to establish this structured means of ensuring the dependability of a study through the use of an audit trail (Carcary, 2009; Creswell & Miller, 2000). In other words, "dependability can be achieved when another researcher concurs with the decision trails at each stage of the research process" (Cope, 2014, p. 89). Throughout the process, an external auditor examined my journal and recorded documentation as they looked for personal bias that may have inadvertently been included in the notes. The suggested questions from Creswell & Miller (2000) guided the process which included the following: "Are the findings grounded in the data? Are inferences logical? Is the category structure appropriate? Can inquiry decisions and methodological shifts be justified? What is the degree of researcher bias?" (p. 128).

Expected Findings

One of the expected findings included the idea that students would indicate a negative mindset about their ability to succeed in mathematics. In other words, the idea that one is simply not good at something, that the ability to learn a certain subject is largely genetic and unchangeable was predicted to be a prevalent belief among students who find themselves in math remediation in college (Kimball & Smith, 2014). In fact, the genetic ability mindset has become so common that the idea of changing student outlooks about their ability to learn has recently been researched with results that indicate "change of belief instruction" as a feasible intervention for struggling students (Paunesku, Gregory, Walton, Romero, Smith, Yeager, & Dweck, 2015).

> We have found that what students need the most is not self-esteem boosting or trait labeling; instead, they need mindsets that represent challenges as things that they can take on and overcome over time with effort, new strategies, learning, help from others, and patience. When we emphasize people's potential to change, we prepare our students to face life's challenges resiliently. (Yeager & Dweck, 2012, p. 312)

In short, it was anticipated that students entering remedial coursework may display similarities among each other in terms of misconceptions about learning and innate ability. It was expected that this finding would be linked to characteristics of students such as willingness to persist, the ability to reflect on themselves as learners, and their overall motivation to learn mathematics.

Another expected finding was that students would point blame for needing remediation on the educational system they were in for their K-12 education. Based on prominent attitudes found recently in the media, students will most likely place some of the blame on teachers, but more of it on the educational system in general that drives teachers to engage in too much test preparation. In other words, the requirements for state testing in grades three through 12 as mandated by the original teacher accountability law in 2001 known as No Child Left Behind (later changed to the

Every Student Succeeds Act of 2015) may be pinpointed by some as a key reason for student failure in the area of mathematics. This tendency to blame outside factors could be linked to learner qualities of self-concept, levels of motivation, and desire for relevance.

A final expected finding was that a lack of reflection and metacognition would be revealed by students in their responses to the interviews even though as adults "Reflection enables us to correct distortions in our beliefs and errors in problem-solving" (Mezirow, 1990, p.1). As described earlier, strategies of andragogy have been implemented as part of K-12 education since at least 2009 including practices of self-directed activities, consideration of background experience, and collaborative problem solving. However, a possible root cause for struggle with learning math for some of these students may be that they have still not internalized how to truly reflect on themselves as learners (Mezirow, 2000).

Ethical Issues

There were no problematic ethical issues in this study, and there were no risk factors involved with the participants. The researcher was an external party with no affiliation with the community college where the study took place.

Conflict of interest assessment. There is no conflict of interest in this study. A phenomenon was identified as one in need of further research, and this study has been completed in order to contribute to the body of research from a new perspective.

Researcher's position. As a mathematics educator, it was important to discover information about students enrolled in remedial mathematics coursework that might lead to improved teaching practices, course sequences, and future collaboration among public school and university systems. However, based on 20 years in the field of education, I needed to put my personal philosophy and opinions aside in order to gain a fresh perspective on the topic of remedial mathematics from students. Once students provided some standard background information, they

were asked to relay their autobiography as a math learner with the option of beginning as far back or as recently as they preferred. In cases in which students did not provide enough of the rich detail, a set of prompting questions were used as needed (see Appendix A). After each interview, I took time to record my personal reactions, feelings, and opinions as a means of bracketing to extract any potential personal bias. This was how I intentionally put aside my own preconceived notions from the study to critically reflect on participant responses during my analysis of the narratives.

Ethical issues in the study. The participants were informed that the purpose of the study was to gather information about remedial math students at the community college level from their personal point of view as a means to contribute to the body of research on this topic. They were also informed that no one would contact them afterwards, nor would their names or the name and location of the institution where the study took place be used in the study. Participants freely volunteered to share their narratives with no incentives.

Summary

Remedial mathematics courses have posed a barrier for many students working towards a higher education degree for decades (Bailey & Jagger, 2016, Bracco, Austin, Bugler, & Finkelstein, 2015). When researching for and conducting this study, it was posited that not enough information was gathered about students from their personal standpoints. By planning a study to include interviews of students experiencing the phenomenon, it would permit them to tell their own rich and varied experiences with mathematics education. Interview results were coded both during and after the one-on-one sessions. Practices of reflexive journaling, peer review, and audit trail were utilized to minimize bias and to ensure reliability and dependability. Engaging students experiencing the phenomenon of enrollment in remedial mathematics coursework to make sense of their placement by recounting their history and perceptions about mathematics was a means to

encapsulate the phenomenon from the student point of view. Afterward, their stories were interpreted in the context of the current body of research and literature on the topic in order to make sense of their narratives as a means to determine what implications the resulting themes might have for the future of developmental mathematics coursework at community colleges.

Chapter 4: Data Analysis and Results

Introduction

The purpose of this study was to discover information about the backgrounds, experiences, and perceptions of community college students required to take remedial mathematics coursework in terms of common characteristics and learning needs. Participants in the study, like thousands of recent high school graduates, enrolled in a community college only to discover they were required to participate in math remediation prior to taking their college math requirements. Designed to contribute to the existing body of research completed on the topic of underprepared math students in community college, this study was conducted through the use of phenomenological interviewing as a means to discover new ideas about the lived experiences of students. "The goal of researchers' using a phenomenological approach to interviewing would be to come as close as possible to understanding the true "is" of our participants' experience from their subjective point of view" (Seidman, 2013, p. 17). Based on a thorough review of the current literature available, this method was chosen as a means to contribute to the body of work to include the student perspective on the issue of remedial mathematics at the community college level.

Description of research questions. The research question and sub-questions were designed to allow for an open-ended approach to interviewing so that themes might emerge naturally by allowing participants to tell their stories as math learners with minimal prompting from the researcher. The core question, "What is the lived experience of students who have been enrolled in remedial coursework in community college in terms of their history as learners of mathematics?" was created alongside the assumption that despite the unique nature of individual learners and their life experiences, there must be some broad set of commonalities that might help shape the way these students are taught or supported when they enter community college. The sub-questions listed below complemented the core question by allowing the consideration of the

participants' history with learning mathematics, possible changes they perceived about themselves throughout their schooling, and how that history connected to their current mindset about mathematics, which might also be connected to the requirement of remediation.

- What themes emerge when participants describe their history as a learner of mathematics?
- How do participants describe any change throughout their years as math students with regard to their personal characteristics, learning preferences, or needs?
- What do participants reveal about their overall mindset about learning mathematics in connection with being placed in a remedial math course at the community college?

Role of the researcher. My experiences as a veteran math educator in public K-12 education coupled with the experience of teaching several sections of a community college-level remedial math course years prior to the study prompted me to question why so many students entering college were still in need of developmental math skills. Based on discussions on this issue with colleagues, I was drawn to acquiring more knowledge about community college students placed in developmental math and what might be done to support their ability to persist through mathematics courses, as well as through a degree or certificate.

Description of the Sample

There were 13 participants in the study, including nine who identified as Caucasian, two as African-American, and two as Hispanic. All participants, except for two, identified themselves within the economic status of middle class to upper middle class, and had graduated from high school within the past eight years. Two of the students expressed that they came from families that struggled financially. They were either pursuing an Associate's degree or specified certificate. Seven participants were enrolled in community college full-time, five were part-time, and one had

recently completed a remedial course and decided to take a break from coursework. Six participants were majoring in General Studies, three in Early-Childhood Education, one in Business Administration, while two were enrolled to obtain a certificate in an emergency medical field. The student who had recently stopped taking courses was enrolled in General Studies. At the time of the study, seven participants were enrolled in a remedial math course, while six had recently been enrolled. As discussed in the methodology chapter, students were recruited through classroom visits of remedial math at the community college and obtaining their e-mail addresses, as well as being referred to participants who had recently taken a remedial course by other participants. Another distinguishing factor among the sample was that seven participants had or were experiencing a computer-based course taking place in a lab, while six were experiencing or previously experienced a traditional lecture course. Of those currently experiencing a traditional lecture course, two of them had already taken the computer-based course in a lab. Four participants distinguished themselves as first-generation college students.

This sampling of remedial students was comprised of students from several different sections and course numbers of remedial math at one community college. Students at this college had several possible pathways through the developmental courses. Two of the most basic courses had the same content, but one was run fully through the use of a computer program with a teacher to assist as needed, whereas the other is a traditional lecture course. This sample of participants included a representation of the formats offered at the community college.

Research Methodology and Analysis

As mentioned earlier, the use of phenomenological interviewing for this study was chosen due in part to a lack of current qualitative studies published on the topic of remedial mathematics. Previous researchers have tended to complete quantitative studies in terms of student enrollment behaviors, demographics, and test scores based on different course modes (Bahr, 2013; Cox, 2015;

Zientek, 2013). The nation continues to have thousands of students in need of remediation upon entry to community college despite decades of attempts at reform (Bailey, Jaggars & Jenkins, 2015). According to Quarles and Davis (2017) there has been little research to determine if reform efforts over the years have resulted in increased student learning or success in community college. While it was found that this statement from Quarles and Davis (2017) was true during research for the literature review, little comprehensive information or results were found to derive from an experiential perspective. Therefore, this study was designed to bring forward issues surrounding remedial mathematics at the community college level from the student perspective.

Phenomenological design. Throughout the research process, information on the background and perceptions of students who had experienced or were currently experiencing remedial mathematics in community college was sought. Information pertaining to student perceptions about the experience of placement in remedial coursework coupled with their beliefs and mindset about mathematics was gathered. The conclusions made by researchers whose work was reviewed in Chapter 2 revealed a need for exploration of the point of view of the lived experiences of remedial math students (Bailey, Jaggars & Jenkins, 2015).

To discern if commonalities existed among remedial mathematics students in community college, participants were engaged in an interview process to give them the opportunity to share their experiences as math learners throughout their lives, and how that connected to their placement in remedial math coursework. The interviews began with participants being prompted to tell their story as math learners, with no particular order or focus. Once participants had given a basic account of themselves, specific clarifying questions were used based on the participant dialogue described by Bevan (2014) as "contextualization" followed by "apprehending the phenomenon" (p. 140). The development of more descriptive questions as previously planned was inspired by the experience of completing three pilot interviews, the conclusions of which indicated

a need for more probing questions about participants' opinions and reflections on their experiences and feelings when engaged in new math learning, as well as their opinion and recommendations about remedial math coursework at the community college.

Bracketing and initial coding of data. Prior to conducting interviews, reflexive journaling, a form of bracketing, was completed to minimize bias during the interviews. Journaling prior to the study included the process of self-interviewing from the perspective of student as well as teacher. Best practices with regard to mathematics education backed by research on mindset remained a strong component of the focus as indicated in Chapter 3. Specifically, aspects of the adult learning theories of Tinto (1997), Knowles (1980), and Mezirow (1991) linking the ideas of persistence, adult learning characteristics, and critical reflection as they pertained to best practices in mathematics education to provide a lens to view the information being gathered through the predetermined codes were used. These codes included Mindset and Beliefs, Learning Style, Teaching Style, Metacognitive Factors, Personal Life Factors, and Barriers. The use of bracketing both before and after the interviews was a means to extract bias while maintaining allowance for the use of Interpretative Phenomenological Analysis, known as IPA, to support the coding of themes (Horrigan-Kelly, Millar, & Dowling, 2016; Pietkiewicz & Smith, 2014; Smith, 2015). As discussed in Chapter 3, Interpretative Phenomenological Analysis is a method that allows for a duality connecting the researcher to the participants. Thus, a two-stage interpretation process, or a double hermeneutic, is involved. The participants are trying to make sense of their world; the researcher is trying to make sense of the participants trying to make sense of their world (Smith, 2015, p.53).

The moment-to-moment coding planned and described in the methodology chapter proved unmanageable because taking copious notes while maintaining eye contact to keep the participants comfortable was deemed more important. Each participant permitted the recording of the sessions.

Consequently, initial coding was completed after listening to and transcribing the recordings. After completing initial coding through the use of the highlighting tool onto the text of the transcribed recordings and the original notes, strong commonalities among participants regarding mindset/ beliefs, and preferences about teaching style/learning style emerged. However, the anticipated significance of personal life factors and barriers did not appear as commonalities among participants. Rather, strong opinions about student advising and course placement emerged as possible themes. Finally, a split in opinion about the use of technology for learning mathematics was a prominent topic discussed by participants.

Summary of the Findings

Development of themes stemming from the initial coding of data was completed upon deeper analysis of statements made by participants based on the themes and sub-themes as they connected to the research question. When considering the prescribed research question in conjunction with the collected data, it became increasingly clear that the lived experience of students who had been enrolled in a remedial course included a set of common experiences and perceptions regarding mathematics despite having different personal backgrounds, life experiences, and future goals. An overall negative mindset about themselves as learners of mathematics as well as a commonly held definition of mathematics as an academic subject was present throughout their narratives. Correspondingly, a commonly held view of how math courses should be taught was revealed, including a strong preference for certain traits among educators. Also, an unexpected theme emerged based on a commonality among participants about their experience with the remedial coursework regarding content alignment across courses and opinions on student advising. Finally, a lack of common ground was discovered that showed a divided opinion on the use of technology to learn math.

The emergence of these themes into possible sub-themes was organized based on commonalities across participants through the use of a matrix which was initially used to determine data saturation as suggested by Fusch and Ness, 2015 (See Appendix A). Following this, as planned in the Methodology section of Chapter 3, I corresponded with two separate colleagues to audit my assessment of the sub-themes. This process allowed me to check that I was not prematurely determining conclusions. It also served as a check for redundancy resulting in the elimination of one sub-theme. I was also able to compare my personal opinions to my preliminary interpretation of the data through discussion, which prompted me to return to current relevant research, specifically centered on mindset and recommended best practices on mathematics education, to avoid relying merely on my own personal experiences. Once the collaborative process with the external auditors was complete, sub-themes were clearly distinguished stemming from the original themes followed by preliminary analysis as to how they related to the research question and sub-questions.

Presentation of Data and Results

While three distinctive themes were identified, they were closely related to each other because they could be used to depict the lived experience of the participants in the study. To establish coherence, the information was organized in a holistic manner by theme. Following this, the themes were synthesized using parts of the narratives provided by participants as a means to connect them to the research question and sub-questions. Preliminary interpretation of the information indicated that despite differences among participants in terms of background, future plans, personality, a commonality was discerned among them when their experiences, perceptions, and beliefs about mathematics was the lens.

Theme 1: Mindset. The theme termed mindset was divided into two sub-themes, the first regarding participants' self-perception as a learner of mathematics, the second an overall depiction

of math as a series of disconnected topics and memorized procedures. The overarching theme directly connects to the research question and can be viewed using the section of the prescribed conceptual framework based on the work of Dweck (2014) and Boaler (2016) who have both indicated a strong correlation between student perceptions about themselves regarding math with their ability to learn it, as well as misperceptions about mathematics as a series of disjointed irrelevant procedures and skills meant to be memorized. The data showed that the majority of participants referred to themselves as "not being a math person." They viewed other people who they considered "math people" as possessing a natural ability in mathematics with no mention of the possibility of work ethic or previous learning experiences that may have contributed to their understanding of math. Negative experiences with others also appeared to generate a negative mindset about math. Several participants explicitly mentioned that their parents held lower expectations for them in math as compared to other subjects. Many participants also indicated being treated differently by teachers who gave more attention to what they perceived to be the "smart" kids. Finally, several participants shared that they were discouraged about pursuing an interest in a field or college degree because they were informed they were not strong enough in math.

The second mindset sub-theme centers on participants' worldview about mathematics as an academic subject. Ten of the 13 participants described math as if it were a series of disconnected topics and memorized steps or procedures (see Appendix A). Participants made statements about solving problems as if there were always an exact prescribed set of steps to follow making statements such as, "I just can't remember the order of the steps" or "I can understand the steps when the teacher is showing it on the board, but I can never remember those steps when I try it myself." Participants depicted mathematics as a subject in which listening to a teacher is how you

learn because they will give you a framework for exactly how to work out every problem they were given.

Overall, the majority of participants described their difficulties with math as stemming from a lack of natural ability, as well as the inability to memorize formulas and procedures for exams once the class topic had shifted. Several participants described themselves as conceptual learners who responded well to visual models, but when probed to discuss what they meant by that, defined visual learning as needing to see "worked out problems" in order to memorize the steps required rather than the conceptual ideas behind visual learning such as the use of pictures or models. Math topics such as operations with rational numbers, solving systems of linear equations, or geometric relationships were discussed as isolated skills or procedures without connections across them or to real world applications. For example, several participants mentioned that they were terrible with one math topic, but were good with another with no indication regarding the direct connection between them. Also, when asked what topics they found particularly difficult, participants appeared unable to note direct relationships between topics such as fractions versus decimals, or multiplication versus division.

Five of the 13 participants explicitly indicated a desire to understand how the math they were required to learn actually applied to real life. For example, one participant stated, "I have been shown slope in class after class ever since middle school, so I know it must be important, so I guess someday I will need it." Another participant described their frustration about mathematics class being un-relatable by stating, "It's as if all the teacher could do to try to relate [a math topic] to real life was to come up with outlandish scenarios that would never really happen." To the majority of participants (10 of 13), math was depicted as a required content that despite having to take a class in it each year of school was thought of as a nebulous series of procedures and steps to memorize where significance to their lives remained mysterious.

Theme 2: Preferred teaching/learning style. The second theme to emerge, Preferred Teaching/Learning Style, was also divided into two sub-themes. Of the 13 total participants, five had just completed a hybrid course, meaning students reported for class in a computer lab and completed self-paced modules with minimal teacher interaction (see Appendix A). Four of those five participants did not prefer this format stating that they did not get enough instruction from the teacher. Of the seven students who were enrolled during the semester of the interviews, three held a preference for the hybrid format at that time. When asked to explain this preference, all three stated it was because they could watch the videos over and over in order to memorize the procedures without having to participate in a class and ask questions. Overall, regardless of the use of technology or not, most participants (10 of 13) described learning mathematics as taking notes while watching the teacher (or video instructor) complete problems on the board. Coupled with this preference, when asked about other modes of learning such as being permitted to work in small groups, they did not think math classes in which students collaborated while the teacher facilitated by rotating from group to group were beneficial. Rather, the majority indicated a desire for traditional lecture with individualized assistance. Overall, participants disliked the idea of being left to work on problems alone or with other students, and held a strong preference to sitting and watching a teacher work out problems on the board.

The second sub-theme of preferred teaching/learning style emerged because of a strong preference from 10 of the 13 participants for teachers who were friendly and attempted to connect with the students on an interpersonal level. Even when participants had failed a course, the "nice teachers" were considered to be effective teachers. On the other hand, distant or unfriendly teachers were described as having a negative influence on success levels of participants in math courses throughout their years in school. Elementary teachers who were considered "warm and friendly" were described as "great teachers" regardless if the participant also described beginning

to get behind in math during those years. High school teachers that were considered "fun and talked to the students about their interests" were also considered "great teachers" despite many participants barely passing those courses. One participant shared that she failed the remedial course she took the first time because the teacher was as she stated, "unfriendly and made me feel stupid." Other participants described their remedial math teachers as not taking the time to get to know students, which they claimed made students feel too uncomfortable to ask questions. Several participants described their remedial math teacher as someone who would get very frustrated with the class when they did not understand what she was trying to teach them. Participants placed blame on teachers for their lack of success in a math class if the teacher was perceived as unfriendly. There was a perception among some participants that many math teachers ranging from the middle school years to community college lacked empathy, compassion, or even an interest in if their students succeeded. On the other hand, when participants felt an interpersonal connection to teachers, they would blame their own lack of natural ability in mathematics instead.

Theme 3: Community college structures. A third theme emerged regarding the community college practices in terms of structure, support, and content alignment which was termed community college structures. Within the first sub-theme, advisors at the institution were seen as unqualified because of not knowing the course sequences for different majors, not placing students in the correct courses, and being inconsistent with requirements. For example, several participants stated that after they took a remedial course and failed it, when they returned to an advisor to discuss it, they were told even though they failed, they could take the credit bearing course required of their major. However, several other participants stated that they failed the remedial course and were required to enroll a second or even third time until they had completed all of the required modules in the course. Another participant stated that he took the remedial

course, failed it, and then was told his placement score was such that he should not have taken the remedial course at all. Yet another participant stated that even after passing one of the credit-bearing math courses, an advisor told them they still needed to go back and take one of the remedial courses because of their previous placement test score, despite having passed the credit-bearing course during the interviews. When prompted to share recommendations for improvements that could be made to the remedial courses, five of the six participants who had already completed a remedial math course mentioned difficulties with advisors in terms of clarity about the course sequence for math required for their particular major or certificate.

The second sub-theme from community college structures was that the course content was viewed as lacking alignment with either the required credit-bearing course or with their program of studies. Specifically, remedial course content was not seen by the participants as the content needed for participants to access the content in their credit bearing math course or as being preparatory for their chosen field. Of the sub-group of six participants who had already completed both a remedial and credit bearing math course, five of them said that the remedial course content did not prepare them for the credit bearing course. In fact, four of those six participants believed that the credit bearing course was actually easier for them to pass than the remedial course, but they did not attribute that to having taken the remedial course. Rather, they identified the credit-bearing content as easier to understand, partly because it included real-life applications, such as learning about statistics on topics such as sports and popular trends.

One key component to this sub-theme, also discussed as part of the learning preference theme was a split in opinion on the usefulness of technology for math learning. It was revealed that while all of the participants were familiar with the use of technology for learning, there was not a clear-cut preference for it as a means to learn mathematics. This finding did not emerge based on specific questions about technology, but surfaced when participants were asked how they

preferred to learn math, or because they had the experience of taking one of the technology based remedial courses. Varied opinions about the usefulness of technology in order to learn math emerged naturally as participants spoke about their lived experiences as community college students in remedial math. Seven participants held negative feelings about learning with technology, four held a preference for it, while two had no strong opinion either way. Criticisms of the computer based course structure included the fact that the course they experienced was essentially a self-study with videos and tests, which was described by several students as not helpful for learning the math concepts they had never mastered previously in their education. Several participants stated that they relied on peers or the student tutoring center for support because the instructional videos were not helpful to them. On the other hand, the four participants that liked the technology-based course stated that they liked the self-pacing, the ability to re-watch the videos as many times as they wanted, and the instant feedback provided when completing practice problems. Five of the participants in particular questioned the wisdom behind placing students who are viewed as not being ready for college mathematics in a self-paced independent study on the computer, rather than in a traditional course with a teacher who conducts lessons.

Exploration of meaning. As a means to engage in rich and thick description of the data, excerpts from the narratives from participants were used to connect the results more closely to the research question. Specific quotes were chosen that were found to be representative of the participants taken as a whole group. For clarity, the themes were unpacked separately up to this point. One of the most frequently heard phrases during the interview process which led to the Mindset theme was either, “Math has never been my thing” or “I am just not a math person.” Dweck (2015), has described this as a fixed mindset about learning mathematics and has pointed out that when teachers are attempting to encourage students away from that mentality, they often unintentionally perpetuate it. As an example, one participant stated,

> I sought out help from my teacher, and after several after school sessions, she told me, "Math just isn't your strongest subject, but that's okay." After that, I believed I was "bad" at math so I didn't do well in my final years of high school.

A fixed mindset about math was described by many others beginning as far back as the intermediate years of elementary and spanning to the time participants were required to take remedial math at the community college.

Answering the sub-question about learning preferences changing over time was not significant since the majority of participants did not indicate a change. Rather, they described a progression over time solidifying a negative viewpoint about themselves as math learners, and of the subject of math itself. As the interviews proceeded wherein participants attempted to explain their self-perception further, they continue to describe math topics they struggled with as isolated skills. Examples of statements made were, "I can do the Quadratic, but everything else, like which equation do I use for this. Or, "Oh I divided a negative so I have to change the inequality sign, that kind of stuff, it just doesn't click and I can't remember what to do" and

> Whatever we were working on, I could do it for the unit we were on, but then when we moved onto something else, I would forget it all. Then when we took a final test, I wouldn't know how to do everything from earlier.

Various other statements from participants revealed a lack of understanding of the existing connections across highly related math topics ranging from as basic as the relationship between multiplication and division, to how the idea of proportional relationships spans multiple concepts. For example, one participant said in an exasperated manner, "I feel like I just don't retain it…when we go onto something else, and I go back to the other material, it's just gone." Statements such as this one directly relate to Boaler's (2016) depiction of students who have a disconnected view of mathematics:

> If you learn something deeply, the synaptic activity will create lasting connections in your brain, forming structural pathways, but if you visit an idea only once or in a superficial way, the synaptic connections can wash away like pathways made in the sand. (p. 1)

Multiple participants appeared to believe this to be exactly what learning is: you "learn" it for the moment, and then it is forgotten as you move on to the next topic.

Despite the overall disconnected view of mathematics, some participants revealed a desire to understand more about how math topics connect to each other or to their lives. One participant stated, "Every class, they keep showing me slope, so it must be important. I guess sometime I will find out why." Another participant reflected with frustration, "I wish math were more about teaching than doing the problems. Being taught how to do the problems instead of just making us do them. Learning the concepts behind the problems instead of just the steps." In this case, the participant meant that she felt too much time was spent in the class for students to practice doing problems rather than receiving direct instruction on how to solve them. She described herself as needing a lecture course in which a teacher modeled procedures in the exact order they should be completed.

Another participant said it would have held his interest more if the teachers would have told him how what they were teaching connected to his career plans, while another complained that so much of his experience with math classes through the years had been teachers coming up with "outlandish scenarios" in order to apply the math in some way. When asked about alternative methods of learning mathematics aside from lecture and guided practice, participants overall indicated they did not want to engage in group problem solving and that they did not prefer being left to figure out methods to solve problems independently. Over time, participants indicated that the lived experience in math classes contributed to a fixed mindset about math ability, and a fixed

view on how learning math should be done (Boaler, 2013). This idea will be explored further in Chapter 5.

Taken as a whole, the mindset theme can be joined to the teaching/learning preferences theme as student mindset was revealed to influence that participants preferred to be taught math in which they were completely dependent upon the instructor. While participants talked about other subjects with confidence such as their ability to independently write papers for other classes and memorize content for them, they revealed a lack of independence when learning math. Some participant statements were reminiscent of Knowles' revised theory on learning needs because of his shift in thinking to account for how different situations or comfort with certain content areas "may cause adults to behave more or less closely to the core principles (of adult learning theory)" (Knowles, Holton, & Swanson, 2014, p. 3). While students described their needs and preferences to learn other subjects with characteristics of adult learners, they depicted their learning needs in mathematics differently. Overall, there was a strong preference for a lecture style course with very little interaction among students. Statements were shared such as, "I just want to be walked through the steps" or "Lecturing with help. I always do better in classes where we would go through the lesson together and work things out step by step, and then had time at the end of class to start homework and ask questions or for help when needed." If the remedial course they took included student group work, participants indicated this as a negative aspect of the course.

Not only was there a prevailing indication of strong dependence on the teacher to present math in a methodical step-by-step manner, but also a perceived need for the teachers to have a strong interpersonal relationship with learners. In fact, when participants reflected on specific classes where they began to get behind in their math understanding, they would show a tendency to blame the instructor if they viewed them as being "mean" or "uncaring." However, as mentioned previously, if the instructor was viewed as being kind, understanding, or friendly, participants

would blame their own lack of aptitude in math instead. For example, consider these contrasting statements: "I didn't do well because it felt like the teacher really didn't care," versus "She was really nice and I liked going to the class, but I got so behind and I couldn't catch up. But she was a good teacher, I just couldn't figure it out because I'm not a math person." In the first instance, the teacher was blamed for making the student feel negatively about themselves which lead to a lack of success. In the second instance, the teacher was viewed as warm and friendly, but not to blame for the student's lack of natural aptitude in the area of math. This occurrence in the participants' narratives about themselves over time was prevalent, including the mention of remedial math instructors.

The course structure of the remedial courses varied from fully online to required hours in a computer lab to traditional lecture courses with minimal use of technology. Of those participants who had been enrolled in the technology-based remedial course, the ones who preferred technology use consistently revealed the desire for step-by-step instruction that exactly matched problems they would be expected to solve. "I liked the fully online course I took before this one because I could watch the videos over and over. It felt more personalized." On the other hand, those who did not prefer the computer-designed course would make statements such as, "If we are seen as not being strong in math or ready for college math, why would they put us on a computer and make use learn it ourselves?" and "I liked the videos fine, but when I needed help, the teacher would come by for like two seconds and then move on, so I could never really get the help I needed." Once again, students revealed a lived experience over time that led them to the preference of traditional course structures consisting of lectures and minimal student participation. This predominant procedural teaching/learning style described by participants is completely counter to that of current best practices as recommended by the National Council of Teachers of

Mathematics, the Common Core Standards, as well as prominent scholars such as Dweck (2015) and Boaler (2016), and will be discussed further in Chapter 5.

Thus far, the themes discussed were readily aligned with the research questions. However, community college structures emerged as part of the lived experience of remedial mathematics students not depicted in the review of literature. This might be explained by the fact that most prominent literature found on the topic of math remediation has been largely quantitative and lacking student input. While not a predicted theme, a trend emerged after three interviews indicating an issue with support structures in place at the community college. This included student advising, the tutoring center, and the content alignment of the remedial coursework had become a source of frustration to participants. During the interviews, participants shared an overall negative opinion about the community college as an organization because they had experienced advisors making mistakes with their placement into remedial coursework, the peer tutoring center did not have the help of actual teachers, and the content of some of the remedial courses was perceived as lacking alignment in terms of preparing one for their credit bearing math requirement.

An overall negative view of advising was described by all 13 participants due to a bad experience with an advisor, or a negative experience from a fellow student. The advisors for the community college are staff members dedicated solely to assisting students with all of the aspects of student enrollment, including using student math placement scores to inform students on which course sequence to take. One participant stated, "I failed the remedial course the advisor made me sign up for twice, then when I went to another advisor, they said my original placement test score would allow me to take the course I needed, and that I shouldn't have taken the remedial course anyway." Another participant said, "Current teacher will start a problem and stop halfway through and then stop when it isn't going well. (Institution's Name) does not have good professors and they

do nothing about it. The advisors are a hot mess—they don't know our requirements one bit, especially now that I have gone to an advisor for (new institution's name)." Several other participants mentioned that their advisor did not explain that the course they were signing up for was computer-based, and that they would have preferred signing up for the lecture version of the course. Several students were very critical of the placement test and suggested that there be more to the process, including taking a learning style test, while others felt it was not fair to have to pay full tuition for a remedial course. For example, one participant stated,

> For me personally I think that a test is not sufficient to place someone in a math class, especially if they are the ones paying for the course. I felt that they were disorganized and often their appointment times were inconvenient. I also wasted a semester because they had me enrolled in the wrong program, an error on their part.

Yet another participant stated that an advisor incorrectly had her enroll in the math requirement for her degree, but afterwards made her go back and take a remedial course because of her original placement test score, even though she had (with difficulty) passed the college math requirement.

Also a part of the community college structures theme, those participants who had already completed at least one remedial math course discussed a perceived lack of alignment of content across courses. For example,

> I had to take it twice which took two extra semesters. But then I took the course I needed and the stuff we were doing was totally different and I understood it better, so I passed. It was statistics which I liked better than algebra.

Other participants described failing the remedial course once or twice, but still being allowed to take the credit bearing course, which they claimed had easier content for them than the remedial course, or that the credit bearing course had better, more helpful instructors. In addition, many participants held negative views about the student-conducted tutoring center, commenting that

students who are adept at math are not necessarily equipped to teach it to someone else. Both the tutoring center and course structure, particularly the computer lab-based course, was viewed negatively in terms of individualized help on math content. Overall, participants revealed a high level of frustration regarding the enrollment procedures in remedial math, separate from the notion of learning. The emergence of this theme contributes to answering the research question about the lived experience of remedial math students despite it not directly relating to the participants as learners of mathematics.

Summary

While the themes described are distinct from each other, they contain meaningful connections that directly relate back to the research question about the phenomenon. Overall, the lived experience of students required to take remedial math at the community college level is multi-faceted since their history as learners, their self-perception, and the structures in place at higher education institutions combine to form the experience. At the time of the study, none of the participants had completed their program at the community college, though two were in the process of final exams which would have led them to completion. While it is not known what percentage of these participants will persist through their program or degree, the themes that emerged are consistent with the work of current researchers who have called for a restructuring of remediation at the community college level. Specifically, the commonality among most participants as having a negative fixed mindset about learning math coupled with a disconnected view about mathematics in a sense explains the largely perceived need to be explicitly directed and shown exact steps to take when solving problems. Furthermore, many participants indicated dissatisfaction with advising practices, teaching format, and content alignment across courses which were seen as contributing factors to a negative mindset about learning mathematics, and a strong preference to remain highly dependent upon instructors versus transitioning to more

independence as described by adult learning theorists. Deeper analysis and interpretation of the meaning of these results will be explored in Chapter 5 through the use of the prescribed conceptual framework as well as existing literature on the topic of community college remedial mathematics.

Chapter 5: Discussion and Conclusion

Introduction

This interpretative phenomenological study, completed at a community college campus in a semi-rural community in the United States resulted in the emergence of themes that uncovered common characteristics among remedial math students. These included similarities in mindset about mathematics, learning preferences, and perceptions about placement policies and content of remedial math courses. In this chapter the themes have been analyzed based on participant insights about their history of learning mathematics, followed by an interpretation of the student perspective as a means to present, explain, and answer the research question and sub-questions in an analytical way.

The results of the research process have been summarized to show how the identified themes entitled mindset, teaching/learning preferences, and community college structures blended together to create a clear picture of the lived experience of remedial math students. An interpretation of what those results mean for institutional policy and practice has been included by connecting the student learning experience to the conceptual framework of adult learning, the most current literature, as well as widely accepted best educational practices of mathematics education in the United States. Additionally, based on the results of this study recommendations for further research to continue broadening the perspectives represented in the research on this topic have been included.

Results of this study have shown that current practices at the community college are not presently aligned with the learning or psychosocial needs of students enrolled in remedial mathematics courses. This is due in part to the fact that high numbers of students enrolled in remedial math entering community college are not only deficient in math content knowledge, but also lack important characteristics needed for adult learners to succeed as specified by Knowles

(1985) and Mezirow (2000). The struggle students described experiencing with math also connected to the concept of mindset as depicted by Yeager and Dweck (2012). The problems arising from a fixed mindset about learning math was an anticipated result indicated in the proposal, was designated as a key theme as described in Chapter Four, and will be further discussed in this chapter. Additionally, the theme of mindset will be analyzed in terms of connections with the other themes on student learning preferences and course structures. Taken together, the three identified themes could be utilized to make a case that the community college experience for students enrolled in remedial math needs improvement. This might be accomplished through changed practices aligned with the recommendations of Tinto (2008) and other prominent researchers, as discussed in the literature review.

Summary of the Results

The goal of this study was to gather information about the lived experience of community college students required to take one or more remedial mathematics courses upon enrollment. The sub-questions were developed to determine commonalities among research participants when asked to communicate their history as learners of mathematics, any learning preferences or needs that had changed over time regarding learning math, and how their overall mindset about mathematics may have been influenced by the remedial math requirement. Based on the review of literature, this study was designed to focus on the possible existence of connections between the life experiences of participants and conclusions made by researchers on the strong influence mindset has on learning mathematics (Boaler, 2015). Another chief concern was to find out if the perceptions and recommendations from participants concerning possible changes in the structure and sequence of remedial math courses aligned with the suggestions made by researchers on this topic, such as Bailey, Jaggars, and Jenkins (2015), and Bol, Campbell, Perez, and Yen (2016).

The method of interviewing began with an open-ended invitation for participants to tell their story as math learners as far back as they could remember. This was followed by more specific questions designed to motivate participants to develop and reflect upon their statements. As previously discussed, this design was created based on the method known as Interpretative Phenomenological Analysis (IPA) (Larkin, Watts, & Clifton, 2006). One aspect of IPA includes the acknowledgment that the presence of the researcher cannot be fully extracted, but bias was attended to through reflexive journaling throughout the process (Larkin et al., 2006). This stance stems from the philosophy of Heidegger regarding interpretative phenomenological research, and guided the decision to design this study under the premise "that humans are embedded in their world and the researcher cannot and should not negate their prior understanding and engagement in the subject under study" (Reiners, 2012, p. 3).

The personal perspective on this topic, which guided the interpretation of the results of this study, originated from the researcher's personal past experiences both as a math learner and educator. Most recently, informal research was conducted through personalized professional development while in the role of middle school math teacher. This was completed through the use of reflective surveys, both oral and written, to discern how the prior experiences and attitudes students held towards mathematics influenced them as learners in the classroom. Moreover, the investigation of current literature on the topic of remedial mathematics in community colleges across the nation enabled analysis of the results from a broad historical perspective.

Throughout the research journey, the work of scholars who have made compelling arguments indicating a need for a complete restructuring on how remedial mathematics students are supported at the community college level was followed (Bailey, Jaggars, & Jenkins, 2015). This recommendation was not made in isolation considering the results of large statewide studies. Specifically, one such study referenced in previous chapters, focused on thousands of students at

community colleges in North Carolina. It concluded that simply taking a remedial course decreased the likelihood of students completing community college (Clotfelter, Ladd, & Muschkin, 2015). The same conclusion was found by many other researchers such as Bahr (2007), Crisp and Delgado (2014), and Douglas (2016). While only one of the 13 participants in this study discussed remedial mathematics as a contributing factor to leaving college, the themes discerned from the participant narratives showed a relationship to the body of literature. Specifically, nine out of 13 participants mentioned they had struggled to get correct information from advisors, and were unclear about the pathway of courses they needed to fulfill their math requirement. Five of the six enrolled in a credit bearing course, having previously taken at least one remedial course, claimed the remedial math content did not align with the content of the required college math course.

Results of other literature reviewed indicated a need for explicit instruction to support the development of community college students into adult learners as defined by the work of theorists, which aligns with the goal of tying the adult learning/mindset conceptual framework to the research findings. Based on her successful work with adult learners during a course called Concepts of Algebra, Rodrigues (2012) recommended that an improvement to remedial math instruction would be the explicit use of adult learning practices as defined by Knowles (2005) to increase student reflection and construction of meaning. Further, Bol, Campbell, Perez, and Yen, (2016) claimed that adding self-regulation and metacognition strategies were an effective means of improving the success of developmental math students. Additionally, the recommendations of Dweck (2015) and Boaler (2016), based on the influence mindset has on ability to learn mathematics, indicated a need for change in the teaching practices of mathematics instructors for any level of student.

Student perspectives gleaned from this study support recommendations from the researchers previously reviewed. For example, the participant narratives revealed a lack of

exposure to pedagogical practices in their remedial courses to support them as learners, including metacognition, self-regulation, or having the content connect in a meaningful way to their life or future career. The depiction of the remedial math experience was described as either lecture style in which students passively watched the instructor model problems, or as students being required to view videos of an instructor modeling problems. Participants indicated that overall remedial coursework felt like an independent study.

The remedial coursework at the site of the study is a prerequisite for enrolling in the college algebra course which is required for all majors that do not pertain to math or science. Students who did not pass remedial math either had to pay to take the course again, or pay to retake the placement test. Several of the participants who had failed a course one or two times before passing it stated that no extra supports were given to them to assist them with getting through the content. Most of the mathematics being worked on were isolated problems with no connections made between topics, or how any of the problems might be used in a real life context. Informal observations made during several sections of the remedial courses during the recruitment process appeared to support this claim from participants. However, full observation of the courses was not a component of this study. During the time of participant recruitment, students were watching instructors work out isolated problems with no context on a whiteboard, or were viewing videos with headphones at a computer station.

Overall, recommendations based on the results of this study have been found to be in alignment with the conclusions made by previous researchers who pointed out a need for the addition of explicit work with students on characteristics important for adult learners to develop alongside learning content (Bailey, et. al, 2015; Dweck 2014; Boaler, 2015). In his earlier research, Bailey (2008) posited that not enough had been discerned about the unique qualities of remedial math students as compared to students who did not require remediation. Bahr (2013),

who had conducted a series of quantitative studies, indicated a need for qualitative studies as a means to further develop ideas on how developmental math programs should be improved. Further, Barnes, Slate, and Rojas-LeBoef (2010) posited a need to consider the difference between college-readiness and academic preparedness. Results of this study may be used to bring forward personal and learner characteristics of remedial math students directly from their point-of-view, and begin to fill this research gap. In this sense, the concept of readiness coupled with preparedness can be combined since remedial math students who participated in the study indicated problematic issues with both. Specifically, the majority of participants revealed a fixed mindset leading to over-dependence on their instructors, as well as gaps in their understanding of math content.

Discussion of the Results

As previously detailed, the large body of available research included many ideas on how remedial mathematics coursework at the community college might better serve the large population of required student participants across the nation. However, the personal perspectives and reflections from students who have experienced required remedial coursework has not been included. As interviews of students were conducted, their narratives could be woven together because of several key commonalities about them as learners of mathematics. The two sections that follow are organized so that first the reader can discern the results from student perspectives tied to the three identified themes, followed by an interpretive section intended to reveal connections across those themes.

Results from student perspective. The objective of discovering common characteristics, perceptions, and opinions among remedial mathematics students at the community college was met when data saturation was evident through the analysis of narratives shared by 13 participants, six of whom completed at least one remedial course, and seven who were enrolled at the time of the

interviews. Overall, both sub-groups understood their placement in remedial mathematics courses as a natural continuation of their history as students prior to entering community college. Statements such as "I have never been a math person," or "I just don't have good ability in math," were commonplace, and while some participants indicated a negative feeling about their math placement at the community college, 11 of 13 participants appeared to believe that the requirement of taking remedial mathematics was the next step in their lifelong struggle with the subject. Several participants described the influence of adults in their early lives as contributors to their mindset about math, including parents and teachers. There was an overall depiction that adults, including parents and teachers, had explicitly expressed the notion that some people having an innate ability they termed a "math brain." In terms of parental influence, participants described math as being referred to as a genetic quality that they must have inherited. Several participants were told by parents that they had to earn top grades in every subject except for math. In terms of teacher influence, some participants described having been told that it was acceptable that math might not be their strongest subject, so they should focus on other areas. For example, one participant stated that a high school teacher had dissuaded her from pursuing a career in veterinary science because of her weakness in mathematics, rather than helping her practice and improve.

A fixed mindset about math was present in nearly every narrative, meaning that participants did not believe their struggle with learning mathematics would ever change.

As participants discussed their history of learning math, they described struggling with isolated skills and procedures revealing a working definition of math as a series of disconnected topics tied closely with their opinion of themselves as learners. When students made sense of their history as math learners as it pertained to their placement in remedial mathematics, they shared that their struggle to learn math was defined as a lack of ability to memorize steps, procedures, and formulas to avoid confusion with other steps, procedures, and formulas. Participants generally referred to

mathematics in terms of arithmetic, and were unable to articulate a broad understanding of the many facets of the subject. Three participants explicitly stated that while they had wondered about how math might connect to their lives or future careers, they had not figured out how. Others shared a belief that math actually did not connect to their course of studies or lives, and questioned why it was a requirement. It could be implied from the narratives that math learning was considered temporary; it was a set of skills you learned in order to pass a test, easily forgotten once the next unit was introduced in class. This commonly shared notion about mathematics indicated that participants had noted how one topic in math connects directly to others, nor to real life applications. Thus, while the theme mindset has been divided into two sub-themes, they can be viewed together to depict how participants made sense of having to take remedial mathematics at the community college. The confluence of these thematic elements have created a worldview of mathematics shaped by a fixed mindset about math ability, coupled with a distorted idea of mathematics as a discipline.

The second theme of teaching/learning preferences revealed that students in remedial math courses have a desire for step-by-step, structured lecture style instruction. The participants were adamant that collaborative problem solving, as well as being individually solving problems was not their preferred way of learning. Five participants specifically traced this preference back to third or fourth grade, siting confusion stemming from the steps required to complete computation problems, such as the United States standard algorithm for long division. Common statements were "I just want to be talked through the steps by a teacher" or "I prefer a traditional course where the teacher shows examples up on the board." Simultaneously, there was also a strong preference for friendly teachers who connected with students on a personal level both during their K-12 school years and at the community college. Participants appeared to interpret their experiences with math classes over the years, including their remedial coursework at the community college, as

being directly influenced by the personality of their teachers rather than how knowledgeable those teachers were about mathematics or teaching methods. Students who responded positively about their current remedial mathematics teacher blamed their lack of success on other factors. However, if they believed the teacher was unkind or uncaring, participants more readily placed blame on them for their difficulties with a course. Participant perception of teacher influence on their mathematics coursework experience spanned from early years of school through the remedial courses at the community college, where the study took place.

The third theme, community college structures revealed that another aspect of the lived experience of students, while separate from their math ability or lack of preparedness, was an influential factor. That is, participants revealed an overall negative impression about the student advisors, course pathways, and course content alignment at the community college. Many participants shared that they had been given incorrect information about the courses, had been enrolled in incorrect courses, and/or had not been informed about the format of the course. In addition, several participants questioned why college advisors, instructed by institutional leaders in the math department, placed them in an independent, self-paced computer lab course with no direct instruction despite having been identified as a student in need of support in mathematics. Further, of the students who had moved onto taking credit bearing math coursework, most claimed that the content in the remedial course did not align or prepare them for future coursework. In three cases, participants stated that the content in the college math course was easier than the remedial course. Several students who thought the credit course was easier attributed it to having a better teacher than they had during the remedial course. Other assertions made by participants regarding remedial course instructors were a lack of feedback given on progress, assigned homework was not checked or graded, and classroom participation was not a requirement of students during class discussions.

Three participants expressed confusion that after failing a remedial course, advisors assigned them to the next sequenced course. Two participants were incorrectly placed in the credit course, but were made to take a remedial course after the fact to correct the advisory mistake. Also, many participants complained that the tutoring center had limited hours, with participant perception being that student tutors were not helpful due to a lack of training in math instruction. In addition to the advisory errors, participants included rich detail about the format of the remedial courses. For example, some of the students revealed strong negative opinions about having to learn math via computer, while others found it useful. However, none of the students perceived having an individual choice of the course format upon enrollment in remedial math, and several participants stated a desire for the process to be fully explained to them by advisors prior to the onset of remedial coursework. Some participants disliked having one test place them into remedial math coursework, while others complained of a lack of consideration regarding their learning preferences prior to being placed in a course.

The commonality with remedial mathematics students in this study is their perception of a lack of opportunity to provide input in the determination of which course format fit them as learners. Interestingly, much of the literature available on remedial mathematics is about the enrollment behavior and course pathways of students at community colleges as a factor connected to attrition (Bahr, 2012; Calcagno, Crosta, Bailey, & Jenkins (2007); Crisp & Delgado (2014). However, in the large body of literature available on these aspects, the student perspective was not included as part of the research. In this study, the theme community college structures has described this student perspective and contributed to the body of research. The majority of participants described negative experiences connected with their frustration in having to take remedial mathematics, because of a lacking system that does not support the enrollment and course pathways of students. As discussed, such negative experiences could lead participants to attrition,

a known risk factor associated with enrollment in remedial mathematics at the community college level (Clotfelter, Ladd, Muschkin, & Vigdor, 2015).

Interpretation of results. While the participants' viewpoints were readily separated into themes based on the way they described facets of their experiences as distinct compartments, this analysis can be described as an 'interpretation of their interpretation' of the lived experience of remedial mathematics in community college (Larkin, Watts, & Clifton, 2006). As referred to previously, Interpretative Phenomenological Analysis rests on the notion that reality might be thought of as "an intellectual construction" in which one "must identify the researcher as an inclusive part of the world they are describing" (Larkin et al., 2006, p. 107). In doing so, it was found that the identified themes were strongly interrelated, and it was not logical to view them in a standard comparative or linear manner. Rather, they can be perceived as an interrelated cycle, much like the figure known as the Mobius strip used as a metaphor by Parker Palmer for how one's inner being influences and is influenced by outside factors. While Palmer (2008) originally used the metaphor to discuss existence in general, for the purposes of this study, a direct connection was made to the work of researchers described in the conceptual framework. This included the importance of critical reflection according to Mezirow (2000) as well as Dweck's (2012) discoveries about the influence of mindset on the learner.

> If you take your index finger and trace what *seems* to be the outside surface, you suddenly find yourself on what *seems* to be the inside surface. Continue along what *seems* to be the inside surface, and you suddenly find yourself on what *seems* to be the outside surface. What look like its inner and outer surfaces flow into each other seamlessly, co-creating the whole. (Palmer, 2016, para. 3)

Palmer's (2016) metaphor of the Mobius strip serves to explain that one cannot pinpoint a clear beginning and end, or cause and effect relationship to every situation. When analyzing a complex

phenomenon, it is important to look for how different aspects influence each other in both directions. Specific to this study, it is difficult to discern how the inner world of participants' mindsets and learning preferences have impacted their outer world, including teaching methods or course pathways/support systems, and vice versa. The identified factors have influenced each other over time to create the total lived experience of remedial mathematics students at the community college level, which is directly related to the research question.

The question, 'What is the lived experience of students who have been enrolled in remedial coursework in community college in terms of their history as learners of mathematics?' was developed since it was difficult to grapple with the astounding number of community college students in need of math remediation as they entered higher education. The results of this study indicated that the requirement of remedial math for these students was a small component of the larger problem in terms of students' lived experience with learning mathematics. Viewed from a global perspective, a culture in America existed prior to these students entering school that included an overall negative attitude about the subject of mathematics (Boaler, 2015; Burns, 1998; Kimball, Smith, & Quartz, 2013). Thus, it was difficult to discern if the mindset of participants stating the firm belief, "I am not a math person" was an original idea they acquired from becoming frustrated at an early age about learning math, or if they were conditioned by those around them, such as when a parent stated that genetics directly affected adeptness in mathematics. Nine participants shared that either a teacher or a parent had communicated a message similar to this, "It's ok that you're not a math person. Just do what you can." This mindset about some people being able to learn math while others cannot is unequivocally false and has served to create a student mentality leading to learned helplessness and the lack of willingness to persevere until one learns a new concept fully (Kimball, Smith, & Quartz, 2013).

Not only did participants of this study enter the remedial mathematics classroom with a negative mindset about their capacity to learn math, they also defined math in an extremely disjointed way. Participants described math in simplistic terms, with concepts being isolated rather than connected. They failed to acknowledge math as a discipline that includes in depth problem solving, logic, and algebraic thinking. Furthermore, when asked to add details to their narrative about math content, the majority of participants did not connect those basic principles together, such as the relationship between fractions and decimals, or even multiplication and division. This issue identified as mindset directly connects to teaching and learning preferences because the fixed mindset about math coupled with a lack of understanding of the breadth of the subject of math has been both caused and influenced by how students were taught mathematics throughout their schooling. Frequent major curricular shifts in mathematics have become customary in American education, likened by Lewis (2005) as a continual game of ping pong, in which at times there has been a focus on procedure, and at other times on conceptual understanding. Lewis (2005) also pointed out students have been presented with math in a manner leading to this mentality: "As compared to students in high achieving countries, American students believe strongly that mathematical talent is innate, and believe less strongly that effort makes much difference" (p. 420-421).

Based on an inaccurate view about mathematics coupled with a perceived lack of aptitude to learn it, participants logically developed strong preferences for a teaching style that included an ardent dependence on teachers to walk them through problems step by step, replicating a static set of procedures to solve problems. Rather than displaying characteristics of adult learners, participants displayed a strong reliance on their teachers, preferring someone who was kind and nice to ultimately support them through their remedial coursework at the community college. This has led to a connection of the first two themes to the theme three, community college structures.

The structures in the community college students identified as frustrating also revealed a large missing component. Not only were advisors perceived as error prone in the assignment of coursework and communication about course formatting, but there appeared to be no support system for developing students into adult learners who connect what they learn to their life, persist through difficult tasks, and take ownership of their own learning through critical reflection (Mezirow, 1990; Tinto, 1987). **"**To make 'meaning' means to make sense of an experience, and then we make an interpretation of it. When we subsequently use this interpretation to guide decision-making or action, then making 'meaning' becomes 'learning'." (Mezirow, 1990, p. 20). However, contrary to the ideas of Mezirow (1990), when participants of this study attempted to make sense of their placement in remedial math, they displayed a set of assumptions about learning math as being superficial at best. When attempting to make sense of this perception, it was concluded that a fixed mindset about themselves coupled with their working definition of math caused them to develop a myopic view of their expectations of a math course. Further, based on comments such as "I just need to be talked through the steps" and "Once we moved onto the next topic, I forgot the previous material," their working definition of what it means to learn also seemed askew. In other words, describing material as so easily forgotten indicated very little true learning had been accomplished during their remedial coursework.

Returning to the metaphor of the Mobius strip, the results of this study indicated that the relationship between the inner and outer worlds of participants contributed to an overall negative view of themselves as learners, and of the subject of mathematics in general. The interplay between these participant aspects created a lived experience in which enrollment in remedial mathematics at the community college was perceived to be the result of years of negative experiences with the subject. It can be inferred that the preferences about learning math brought up by participants was based on their lack of comfort with the subject rather than their ability to

reflect on their own needs as adult learners. Specifically, it appeared that a fragmented view of mathematics and lack of confidence in themselves led 10 of the 13 participants to depict their preferences as learners to find courses in which the teacher lectured and gave step-by-step instruction they could mimic. Similar quotes were found in 10 of 13 narratives much like the following examples: "My teacher told me I was not a math person and that it was ok," or "My parents were not math people, and neither am I." Their narratives continued with comments such as, "I would learn the concept while were on that unit, but when we moved onto something else, I would completely forget what we had already learned, so I would fail the tests."

Participants showed a fixed mindset about their lack of ability to learn mathematics coupled with a view of mathematics as a series of memorized procedures and steps. This was due in part to the fact that "the provision of ways to see, understand and extend mathematical ideas has been under-developed or missed in most curriculum and standards in the US, that continue to present mathematics as an almost entirely numerical and abstract subject" (Boaler, Chen, Williams, & Cordero, 2016, p. 1). Again, the interaction of participants' outer world and inner world has combined to form both a negative and distorted view of mathematics as a discipline.

To synthesize how the results of this study connected to each other, it was important to consider how the relationships between the inner and outer influences that created the lived experience of remedial mathematics students intermingled. Every participant in the study depicted some degree of struggle with mathematics throughout their K-12 years, and had already developed a negative fixed mindset about their ability to learn math prior to community college enrollment. This mindset was connected to a lack of confidence or ability to grasp concepts quickly in the early years of learning (inner influence), alongside attitudes passed along to them by parents, teachers, or other influential adults in their lives spanning all of their years in school (outer influence).

When placed into remedial math at community college, participants connected their previously existing fixed mindset about math to having to take such coursework (inner influence). Participants appeared to rely on emotional support from teachers, and were often disappointed by the lack of connection they felt with their remedial math teachers (outer influence).
Over time a preference for teachers who engaged in lecture methods, those in which students copied down steps to be memorized and used with identically structured problems with a different combination of numbers, developed. This appeared to result from participants' negative mindset about math and lack of depth of understanding that all of the topics in mathematics connect to each other and to real life applications. This can be construed as a combination of inner and outer influences since the inner mindset about mathematics affected how they believed content should be shown to them.

Because of the development of the preference for passive learning and traditional lecture, participants also developed a strong dependence on instructors to allow them to pass courses by memorizing steps without true understanding of the mathematics content or how it connected to life or career. This was found in participant narratives both when they discussed teachers prior to and during their time at the community college. While the perception of their remedial math instructors might be considered part of the inner mindset, it could also be construed as an outer influence in that the course structure and methods of teaching were not conducive to supporting the needs of the participants. Finally, the outer influence of how students were advised or supported, and how the courses were structured and ordered appeared to contribute to a negative view of being enrolled at the community college. The interplay between inner and outer influences connects the three themes together, and can be used to paint a clear picture of the lived experience of remedial mathematics students at this community college.

Discussion of the Results in Relation to the Literature

When returning to existing work on this topic to compare how the results of this study tie to the community of practice, the previously completed research, and the community of scholars, the information gathered from participants gave voice to the conclusions iterated in studies and compilations of studies completed over the course of the past few decades. The frustration and attitudes about math from participants in this study indicated a need for changed practices at the community college level as has been recommended repeatedly over several decades. As stated by Braun, Bremser, Duval, Lockwood, and White (2017),

> We call on institutions of higher education, mathematics departments and the mathematics faculty, public policy-makers, and funding agencies to invest time and resources to ensure that effective active learning is incorporated into post-secondary mathematics classrooms. (p. 124)

This request originated from the 2016 Conference Board of the Mathematical Sciences (CBMS), which is an amalgamation of seventeen total professional groups on the mathematical sciences (Braun, et. al, 2017). The results of this study can be interpreted to support this request, and aligns with the conclusions found by researchers depicted in the literature as discussed in Chapter 2.

Influence of mindset. As discussed in the review of literature, Bailey (2009) pointed out that it was not known what specific differences existed between students in need of remediation and students who did not have that need. The results from the first theme labeled mindset indicated that one key difference among students may be that those in need of remediation possess the well-documented negative fixed mindset about learning math coupled with a disjointed view of mathematics as a discipline. In fact, 11 of the 13 participants specifically discussed such a mindset. This result aligns with recommendations from researchers that there is a need in the community college classroom to explicitly discuss and develop a growth mindset (Dweck, 2014).

For example, based on their research on this topic, Yeager and Dweck (2012) reported the following:

> We have found that what students need the most is not self-esteem boosting or trait labeling; instead, they need mindsets that represent challenges as things that they can take on and overcome over time with effort, new strategies, learning, help from others, and patience. (p. 312)

The discovery of a fixed negative mindset about learning mathematics in participants can also be tied to the conceptual framework of this study in connection to the idea that adult learning should be steeped in the idea of transformation. It can be implied by the number of participant comments on their view of themselves as learners and their narrow view of math as a discipline that they were in need of coursework that included work on changing their worldview on learning mathematics. According to Mezirow (2000), "Learning occurs in one of four ways: by elaborating existing frames of reference, by learning new frames of reference, by transforming points of view, or by transforming habits of mind (p. 9).

Several of the studies reviewed in Chapter 2 support the notion that students in remediation in community college need explicit experiences to develop into adult learners, and that when they are given such support in areas such as self-regulation and metacognition, their math achievement improves (Bol, Campbell, Perez, & Yen, 2016; Garcia, 2003). Such work on developing adult learner characteristics could also directly connect to increased active learning practices as recommended by Braun et al., (2017) which correlates with current best recommended practices from the National Council for Teachers of Mathematics (2014). For example, demanding that students become more actively engaged in their learning is a means to develop adult learner characteristics as depicted by Knowles (1984), such as increased involvement in one's learning and becoming more problem-centered rather than content-driven (Kiersley, 2010).

Based on the results of this study, there is need for community college instructors to conduct explicit work to shift mindset about mathematics while simultaneously developing remedial students into more independent and reflective thinkers. This notion was developed based on results indicating that the majority of participants revealed a fixed mindset about themselves as learners with a strong dependence upon instructors, and can be reinforced by the recommendations made by multiple researchers found in the literature review (Bailey et. al, 2015; Bol et. al, 2016; Knepler, Klasik, & Sunderman, 2014; Okimoto & Heck, 2015; Yeager & Dweck, 2012; Zientek, Ozel, Fong & Griffin, 2013).

Reshaping learning preferences. It is a complex undertaking to interpret another's interpretation of a lived experience. However, when viewed together, a simplicity can be found with distinct similarities among the 13 participants of this study showing a strong connection between mindset about learning math, their working definition of the discipline of math, and their discussion about how they preferred to be taught math in the community college setting. Bailey (2008) posited that one problem with the failed redesigning of community college remedial coursework was that it was unknown how such students differed from their counterparts that did not require remediation. One possible key difference that emerged from this study was a negative mindset about math combined with a lack of understanding about their own learning preferences and needs. The participants in the study, through their depiction of themselves as learners and their perceptions about their learning preferences, revealed a lack of adult learner characteristics lacked the ability to deeply reflect on themselves as learners, and did not purport the motivation or willingness needed to persist through content they found difficult. Rather, they preferred being shown new math learning as a series of skills and procedures they could memorize based on modeled examples, and described the math requirement as something to endure in order to obtain their degree, with no connection to their personal life or career.

In the literature review, multiple researchers pointed out the need for remedial college students to be challenged more rigorously, both as learners of math content and as students who critically self-reflect as learners (Bol et. al, 2016). As called for by multiple researchers, including those on the Conference Board for Mathematical Sciences, community college students need to be challenged to engage in active learning and to engage in self-regulatory strategies stemming from the concepts of andragogy (Bol et al., 2016). In short, the expressed preference for passive lecture-style learning should not be applied to the restructuring of remedial math courses. Rather, the opposite should occur in which students are encouraged to engage in reasoning and problem solving based on purposeful mathematical discourse as they make real-world connections to learning (National Council of Teachers of Mathematics, 2014).

Access with support. As discussed, participants in this study showed they lacked prerequisite knowledge of mathematics coupled with a dearth of key adult learning characteristics that might support their long-term success. Open enrollment to college is not enough (Engstrom & Tinto, 2008). There is need for a stronger support system within the classroom to assist them in developing the learner characteristics needed to persist through a program (Tinto, 2012). The needs of underprepared community college learners will not be met by simply providing students with the content they are missing. A stronger community of learners needs to be formed by creating cohorts that enroll in courses together, as well as engaging students in their own education through teaching strategies, such as project-based learning and cooperative learning (Engstrom & Tinto, 2008).

As discussed, the learning preferences participants described were actually aligned to the type of instruction the participants described happening in most of the remedial courses. Therefore participants were apt to blame their own inadequacies in math rather than the course structure. Some students were critical of the hybrid course because they likened it to an independent study

with little to no interaction with the instructor. Overall, the depiction given by participants of the support systems in place to assist them did not sound sufficient, and were described similarly to the course structures described in remedial courses across the nation with bleak pass rates such as those referenced in the state of North Carolina (Clodfelter, Ladd, Muschkin, & Vigdor, 2015). Specifically, several students had already failed at least one remedial course, while several others expressed a lack of confidence to pass their current course the time of their interview for this study.

Changed practices with remedial students are needed. While participants shared the desire for lecture style classes and being given every step to follow, that method will not help them develop a growth mindset, nor will it deepen their conceptual understanding of mathematics. Rather, active learning strategies need to be employed, such as inquiry-based learning and collaborative protocols, both of which have been shown to increase student persistence while better informing educators of student progress (Braun, et. al, 2017). While the narratives from participants in this study indicated that the majority of them did not prefer collaborating with other students, it can be inferred that their lack of comfort in mathematics over the years, as described by them, had caused them to fear exposure of their lack of understanding in math classes. To support student success with such learning Engstrom and Tinto (2008) recommended that these four components be included: clear expectations, support, timely feedback, and required involvement. Participants in this study indicated that they had felt a lack of support from advisors and teachers, at times were unclear about expectations, and had not been required to interact with other students in their remedial courses. For example, expectations about homework were unclear, as instructors would assign homework, but not go address it in class or collect it to grade or provide feedback. While participants were not complaining about the lack of those four components, it can be inferred the need of them existed.

It is important to point out that enrollment in remedial math as a direct cause of attrition, as found by Clotfelter et al. (2015) and Crisp and Delgado (2014), was not a direct part of the data collection for this study. The majority of participants shared an anticipation and acceptance of having to take remedial coursework in math based on their history with the subject. While the difficulties mentioned about student advising and course alignment, as well as a general negative view of teacher interaction, was prominent in the narratives it cannot be known from this study if participants will persist through their degree or not. Conclusions about the influence of remedial mathematics on continued enrollment as part of this particular study is not feasible since only one of the 13 students had stopped taking classes, while one was graduating having passed the course in her last semester, meaning an advisor had placed her incorrectly in the credit bearing course prior to completing the remedial course. The 11 remaining participants were still enrolled at the school at the time of the study. It can be inferred from the narratives that the negative experiences they depicted centered on advising, course structure, and teacher interaction could have a negative impact on participant willingness to persist through a program in the future.

Limitations

The absence of member checking with participants was anticipated as a key limitation to this study, as stipulated by the Institutional Review Board of the study site. This meant there could be no follow-up sessions with participants to clarify meaning of their responses during the interviews, nor could additional questions be asked at a second interview. Therefore only the initial notes and recordings of the interviews were utilized, without additional data from the participants to extend meaning and check for clarity of responses. A second, unanticipated limitation was the timing of the study. Approval to proceed was granted as the fall semester was ending. Thus, participants were recruited both during the end of the fall semester and the beginning of the spring semester. However, since data saturation was reached with less

participants than planned, the process was expedited by using 13 participants rather than 20. This actually allowed for interviews of students who had recently completed a remedial course, and other students in the midst of a remedial course.

Another limitation was based on the initial recruitment of the participants. Only students who were willing to discuss their experiences were interviewed, and it cannot be known if those who were unwilling to participate held different viewpoints, such as more negative or positive views of remedial math. For example, the seven participants who were currently enrolled in a remedial course did not share any negative perceptions about their current teacher, while five of the six who had completed the course did share negative opinions on how the course was taught.

Implications of the Results for Practice, Policy, and Theory

Practice. The components of the remedial courses as described by participants indicated a lack of the recommended practices as specified by both the National Council of Mathematics (2014) and the Conference Board of the Mathematical Sciences in terms of active learning and the development of problem solving ability (Braun et. al, 2017). There also appeared to be a lack of work with students to develop them into more independent learners, with no indication of work on metacognition, self-regulation, or connections made that would assist students in linking their math learning to their lives or future careers. This was evident despite the large amount of literature whose writers have indicated increased success rates of remedial students when such practices were implemented (Bol, et. al, 2016; Garcia, 2003; Zientek, et. al, 2013).

Additionally, all 13 participants made a least one comment about the teachers at the community college not requiring student engagement in their course, while several mentioned they did not engage in positive interpersonal communication with other students. Regardless of the accuracy of this perception, the lived experience of participants was depicted in this way. What might be inferred from this perception is that the remedial coursework was not presented in a way

that the students found accessible, and did not include strategies to assist them in becoming independent problem solvers. In the review of literature, it was found that explicit work on self-regulation strategies, metacognition, and the building of a community of learners should be infused as part of the remedial course experience (Bailey, Jaggars & Jenkins, 2015; Bol, Campbell, Perez & Yen; 2016; Rodrigues, 2012; Tinto, 2008). Perhaps the student perception about their instructors was their only way of expressing the need for such practices. Throughout his work on student persistence, Tinto (2008) framed the needs of community college students from the perspective that these students typically do not have the privilege of living as a community on campus, and often have jobs or family responsibilities that might prevent them from creating strong social connections with their peers. Thus, strategies designed to inspire persistence through a program must take place in the classroom (Tinto, 2008).

Findings in this study support the notion that explicit work on developing qualities of adult learners as specified by Knowles (1984) would help support the learning of remedial math students. Specifically, 10 of the 13 participants indicated not only a negative mindset about mathematics, but also showed that they were not functioning in math class as adult learners, and not exhibiting the qualities specified by Knowles (1984) including self-direction, motivation, use of background experiences to support new learning, and establishment of clear goals. To support students, the guided pathways model suggested by Bailey, Smith, and Jaggars (2016) can be implemented. This would allow the learner qualities students should develop over a semester to be mapped out by faculty to help foster metacognition and increased motivation in students.

Returning to the specifics of mathematics learning, results of this study also indicate that students enrolled in remedial mathematics could benefit from explicit work on shifting from a fixed mindset to a growth mindset. Every participant at some point during their narrative mentioned not possessing a natural ability in mathematics. Most went into great detail about

struggling with math during their school years revealing an overall negative view of themselves as well as the subject of math itself. Dweck (2006), who studied mindset in depth found that students who have a growth mindset learn new content more readily than those with a fixed mindset. However, Dweck (2015) has since revisited the mindset theory and cautioned educators that it is not an easy proposition to completely change one's mindset simply with encouragement and discussion about it. Rather, developing a growth mindset in students is more of a gradual reflective process, as they are encouraged to consider their feelings about learning new content and how those feelings at times act as a barrier. Boaler's (2013) extensive use of Dweck's (2012) research on occurrences in the brain when analyzing mistakes in mathematics as well as her own research among all ages of math students led to these conclusions:

- The plasticity of the brain: ability and intelligence grow with effort and practice,
- The importance of students' mindsets for learning: when students believe that everybody's ability can grow, their achievement improves significantly.
- The importance of teachers' mindsets for teaching: when teachers believe that everybody's ability can grow, and they give all students opportunities to achieve at high levels, students achieve at high levels. (p. 150)

Results of this study showed mindset as a prominent theme, and when connected to the themes about learning preferences and community college structures, supported some of the important recommendations discussed in the literature review on the topic of remedial mathematics. That is, in addition to the learning or re-learning of math content, community college students in remediation showed a need for structure to their coursework in which their learning habits, mindset, and overall development towards becoming adult learners is explicitly addressed (Bailey et al., 2015; Boaler, 2013; MacGregor, Tinto, Linbald, 2000; Yeager & Dweck, 2012).

Theory. As far back as 1968, the problem of learning deficits as students entered community college has been discussed, with recommendations including changes in placement procedures, course content, and improvement of teacher training (Rouche, 1968). Moving forward to more recent years, many researchers have recommended that community colleges adjust the remedial course placement process, create a clearer content pathway of courses, as well as train teachers to include explicit work with remedial students on self-regulation and metacognitive strategies (Bailey, Jaggars, & Jenkins, 2015; Ngo & Melguizo, 2016; Scott-Clayton, Belfield, & Belfield, 2014). According to Osterman (2012),

> The vast majority of students recount an experience in community colleges in which there is virtually no counseling or support, in which pathways to the desired degree or credential are very unclear, in which there are few signposts of progress or intermediate achievements, and in which most flounder and give up. (p. 142)

The results of this study clearly indicated that participants had not received any interventions to assist them with their lack of readiness for college mathematics other than being enrolled in coursework that included a review of basic isolated skills and procedures. Furthermore, theories of adult learning or andragogy were not addressed in terms of inspiring students to become more active participants in their own learning.

Policy. Nationwide, it has become commonplace for community colleges to offer open enrollment. However, in reference to open enrollment Tinto (2008) wrote, "Access without support is not opportunity" (p. 1). Participants in this study indicated they had open access to attending the college, and could take the remedial courses multiple times if needed for full tuition, but also indicated there was a lack of support for them to learn the mathematics content they were lacking based on the placement test. Descriptions of both the hybrid and lecture courses showed that they were content driven with no embedded learning strategies such as self-regulation,

metacognition, or even classroom discussions taking place. Participants depicted their understanding of the content being learned as fragile and shared very little understanding of how the mathematics they were learning might connect to their lives or future careers. In addition, when participants described the enrollment procedures completed with advisors, they were not given information about the different versions of the remedial courses in term of format, and were at times incorrectly placed. As discussed in the review of literature, Ngo & Meguizo (2016) have pointed out a key factor that has caused remedial coursework to become a barrier for students as an inconsistency in the use of cut-off scores to place students in courses.

Based on the narratives from the participants, there were no structures or support systems in place for students who were failing remedial courses. The only accommodation shared by those who had taken the online hybrid course was that they were given permission to take the course more than once with their work from the previous course saved in the computer system so that they could continue the modules where they had left off in a previous semester. It was found in the review of literature that this lack of support of students is commonplace at the community college level, and a call for clearer policies has been made by scholars who have pointed out that discord exists among those who want high academic standards and those who want more equity in access to higher education (Melguizo, Kosiewicz, Prather, & Bos, 2014). The results of this study are in alignment with the conclusions of researchers who have indicated that policies need to be implemented that include a well-defined structure for community colleges to follow so that a proper support system is in place to bolster the success rates of remedial math students.

Recommendations for Further Research

As is the nature of many qualitative studies, this was a small study conducted by one researcher at one community college. Despite this, the results aligned well with recent research on the issue of remedial mathematics, and could easily be replicated in schools across the nation with

different course structures, demographics, and other differing factors. For example, it would be noteworthy to determine if differences between the lived experiences of students who attended K-12 schools in different states were similar to the participants in this study. In the case of this study, social economic status did not appear to be a factor based on a follow-up question that addressed this with each participant. Participants came from a range of middle socioeconomic to high socioeconomic backgrounds, with two reporting that they were the first in their family to go to college. Future studies could be conducted at multiple schools with contrasting populations in order to determine if these factors have influenced the lived experience of remedial learners.

Another concept for future research could include a focus on teaching practices occurring in community college classrooms. This could consist of observations of full sessions of remedial mathematics courses to note elements such as teaching practices, levels of student engagement, and the level of use of technology. A larger study that included multiple sites would be useful for noting levels of success rates of students as compared to what teaching techniques were being utilized. While analysis of research on remedial students indicated an overall lack of focus on the student point-of-view, there was also a lack of inclusion of the professor point-of-view. It would be beneficial to collect information from instructors regarding their educational background, teaching philosophy, and their perception of the course structures they are required to utilize. This information could be important in order to make recommendations for policy change based on Tinto's (1975) original theory that cited the connection between student persistence and interactions between teachers and peers in the community college setting.

Conclusion

Based on results of large studies across the nation, the current state of remedial coursework at the community college level is ineffectual (Clodfelter, Ladd, Muschkin, & Vigdor, 2015). However, upon review of the existing literature, it was found that there were no comprehensive

studies available that included the student narrative on this issue. In this study, this missing component was explored in order to add to the national conversation about how to increase the success rates of students enrolled in remedial mathematics at the community college. The information provided by students experiencing required remediation offered a viewpoint that allowed for the creation of recommendations based on a combination of student views in conjunction with existing research.

Results taken from the accounts of participants indicated an alignment with recommendations by prominent scholars to include explicit discussion and work on mindset and self-regulation strategies to support students who are deemed to lack readiness for college level math content (Boaler, 2015; Bol et. al, 2016). Recommendations from participants, none of whom had knowledge of the research on the topic, were surprisingly aligned with ideas found in prior research as they questioned placement procedures, advising, and course content. Once again, the Mobius strip metaphor was pertinent where the inner world and outer world experiences with learning mathematics interacted to create inaccurate views of the self, and of mathematics as a discipline. Clearly, the lifelong negative and fixed mindset about mathematics should be addressed with students in remedial mathematics courses as the research of Yeager and Dweck (2012) has indicated. In addition, Bailey's (2008) call for the discovery of the unique differences among remedial students can be answered through the words of participants who not only revealed a strong negative mindset about mathematics, but also a lack of adult learner characteristics and a need to persist through college level coursework (Tinto, 2008). This exploration might also include effective ways to integrate technology into learning for the community college student (Bullen, 2016).

The results of this study also align with the call for increased student engagement in the college mathematics classroom as specified by the Conference Board of the Mathematical

Sciences (CBMS) in 2016 (Braun et al., 2017). Overall, participants in this study described the experience of remedial math courses as one in which they were passive observers of teachers solving problems on the board for them, followed by practicing problems in which they mimicked teacher procedures. Researchers have studied the effects of active learning practices in community college classrooms, and reported positive results (Braxton et al., 2000; Kuh et al., 2011; Okimoto & Heck, 2014; Reiners, 2012; Twigg, 2011). Yet as Bryk, Gomez, Grunow & LeMahieu (2015) pointed out with regard to education reform, as a nation, institutional stakeholders have not embraced such research findings. True improvement can only occur through reforming the actual work happening in classrooms on a daily basis (Tinto, 2012). The results of this study align with these conclusions.

While findings and recommendations from this study are not completely new, the voice of students living the experience of remedial mathematics has been added to the dialogue. The overarching results based on the analysis of student narratives aligned with recommendations of many prominent scholars and researchers that remedial mathematics students in community colleges need an alternate approach. This would include different practices in content delivery, and more importantly the infusion of explicit work with students to support their growth into adult learners with a strong focus on developing a growth mindset about mathematics through active learning experiences. Access to college is not enough, and equity lies in changed practices consistent with recommendations made by scholars in the comprehensive body of literature available to community college stakeholders, as well as in the personal narratives of the participants who allowed me to add their voices to the conversation.

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Appendix A: Interview Protocol

Researcher's scripted introduction: Thank you for agreeing to tell your story as a math learner. Think of this as telling your autobiography as a student of math. You can begin as far back in time as you like, and you may jump around as you remember things. Try to paint as vivid a picture as you can of your background and experiences when it comes to learning math. Please do not include the names of any teachers or schools you attended. I am collecting this information to increase the knowledge about student needs in remedial math coursework at the community college level. We will begin with a few structured questions, followed by time for you to tell your story as a math learner. Remember, everything you share today will be anonymized and all of my notes as well as the audio recording will be kept in locked cabinet at all times and will be destroyed 3 years after completion of the study. If at any time you feel uncomfortable discussing this topic, you may end the interview with no negative consequences and your information will not be included in this study. Do you have any questions?

Introductory Information: Please give me a bit of background about yourself as a student to the community college.

- Are you pursuing a degree or certificate?
- What are your plans after finishing your degree/certificate?
- What is your enrollment status? (part-time, full-time)
- Are you currently employed?

Participant Narrative: Now, please tell me your autobiography as a math learner. Again, you may begin as far back as you like, and you may jump around through time as you remember things. Think about your experiences when learning new math concepts, the types of activities you were given by teachers, and your feelings, perceptions, or opinions about those experiences (please do not use the names of people or places).

Bank of questions for use if needed to get to the ideas from the sub-questions:

What themes emerge when participants describe their history as a learner of mathematics?

- Do you recall specific examples of when you felt frustrated or unhappy when learning math?
- What kinds of activities do you remember doing in elementary school? Middle school? High school?
- What math did you find easy to grasp and what did you find most difficult?
- What kinds of activities do you think helped you learn mathematics?

How do participants describe any change throughout their years as math students with regard to their personal characteristics, learning preferences, or needs?

- What kinds of math lessons did you find enjoyable when you were younger? How has that changed over time?
- Do you prefer working independently or with other students when learning math?
- Has your learning style changed over time or has it remained the same?
- Do you recall specific time periods when you enjoyed learning math?

What do participants reveal about their overall mindset about learning mathematics in connection with being placed in a remedial math course at the community college?

- Would you describe yourself as independent of or dependent on your instructor when learning math? Or both to some degree?
- Is math an important subject for you to learn? Why or why not?
- Are you good at math?
- What is your opinion on being required to enroll in a developmental math course?

Clarifying the Narrative: As students tell their experiences as math learners, some clarifying questions may be needed:

- When you said _____, what did you mean?
- Would it be accurate for me to say you mean _____ by your response to this question?
- I heard you say _____. Can you explain with more detail exactly how that has impacted you as a learner of mathematics?

Follow-up: I am now going to read back to you what I have written based on your narrative today. Please stop me if you want me to change how I have phrased something, or if you would like to add additional details.

Conclusion: Now that we are finished with the interview, I have a few basic questions about your background. You may choose to answer these questions or pass.

- From what race(s)/ethnicity do you identify?
- What level of education did your parents/step-parents complete?
- Describe the socio-economic status of your family when you were growing up.
- Are there any life factors you have not yet discussed that you think may have influenced your ability to learn math during your K-12 years?

Appendix B: Original Interview Recording Tool

Participant Number: ____ Date: Time: Location:	Initial Codes for Notes: 1: Linked to sub-question 1 2: Linked to sub-question 2 3: Linked to sub-question 3 A-Beliefs/mindset B-Teaching style C-Learning style D- Metacognitive Factors E-Personal life factors F-Barriers to learning

Appendix C: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does "fraudulent" mean?

"Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate's final work without full and complete documentation.

What is "unauthorized" assistance?

"Unauthorized assistance" refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (Continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University- Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association*

X

Janet Wood Varner

Digital Signature

Janet Wood Varner

Name

10/20/2018

Date