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Mindset Matters: Supporting Student Persistence Through The Developmental Mathematics Pipeline

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Mindset Matters:  
Supporting Student Persistence Through The Developmental Mathematics Pipeline

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Education

in

Teaching and Learning

by

Tracey Nicole Kiser

Committee in charge:

Christopher P. Halter, Chair
Amanda Datnow
Gabriele Wienhausen

2016
The Dissertation of Tracey Nicole Kiser is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

________________________________________________________________________
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Chair

University of California, San Diego
2016
Dedication

I dedicate this dissertation to my family, friends, and students. Thank you for your continual love and support. To my students, thank you for teaching and reminding me why I was chosen to inspire on a daily basis. In addition, I dedicate this dissertation to anyone working hard to succeed in life. You can do it! Believe in yourself! Trust the process (Proverbs 3:5-6). Remember, you can do all things through Christ because he gives you the strength to do so (Philippians 4:13). Be Blessed, MUAH!!!

The following quote increases my motivation for writing:

“If writing a book is impossible, write a chapter. If writing a chapter is impossible, write a page. If writing a page is impossible, write a paragraph. If writing a paragraph is impossible, write a sentence. If writing a sentence is impossible, write a word and teach yourself everything there is to know about that word and then write another, connected word and see where the connection leads.”-Richard Rhodes

To me this quote simply says, NEVER EVER GIVE UP!!!
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“If you were successful, somebody along the line gave you some help. There was a great teacher somewhere in your life. Somebody helped to create this unbelievable American system that we have that allowed you to thrive.” – President Barack Obama

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Vita

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Abstract of the Dissertation

Mindset Matters: Supporting Student Persistence Through The Developmental Mathematics Pipeline

by

Tracey Nicole Kiser
Doctor of Education in Teaching and Learning
University of California, San Diego, 2016

Christopher P. Halter, Chair

Developmental mathematics is one of the most challenging leaks in the mathematics K-20 pipeline. Few students enter two-year colleges prepared to successfully engage in college-level mathematics classes. Many of students who place into developmental mathematics are low-income, underprepared, students of color, and many are not equipped with the necessary resources to help them persist through college Math placement predicts college success, and being placed into developmental mathematics makes it less possible for students to not only transfer from a community college to a university, but also graduate. Students who place into developmental mathematics can spend most of their community college experience relearning and building on skills they should have mastered in high school.

This study investigated developmental mathematics, strategies for maximizing students’ success in developmental math classes, and the interactions between students’ social and physical environments that mediate their thinking and understanding of developmental mathematics. As a result, multiple methods of data sources (survey, field
note observations, focus group interviews, and semi-structured interviews) were used to better understand students and teachers’ characterizations of accelerated developmental mathematics.

The overarching finding in this study was that the mindset of students matter. Mindsets determine students’ decision-making and their motivation as a result of past math experiences. Consequently, students enter college with a lack of confidence in their ability to succeed in developmental mathematics, which affects their ability to transfer to a university and obtain a degree. While students past math experiences did not make them feel like they could grow mathematically, their personal lives motivated them to develop and grow as a whole individual. In-class practice and tutoring support were also instrumental to student success in developmental mathematics. This research study contributed knowledge about students’ learning needs, faculty perceptions of the students’ learning needs, the ways their instructional practices address students’ learning needs by using their voices to shed light on effective strategies for maximizing students’ success in developmental math classes.
Chapter I: Introduction

“Remedial math is a dream killer for many students.” – Robyn Toman

Persistence in Community College

According to Bailey (2009), “developmental education is one of the most difficult issues confronting community colleges today” (p. 1). As a result, developmental programs were created as a potential gateway for students who enter college under-prepared for college-level coursework. However, students who are required to enroll in developmental programs are less likely to obtain a degree, certificate, or transfer to a four-year university. According to Tinto (2001), “more than 47 percent of all students in America who start at a four-year college fail to earn a degree at that college; and nearly 56 percent of all dropouts from four-year institutions leave before the start of their second year” (p. 1). Although retention programs have helped some college students persist and complete their college degrees, “long-term impact on retention has been surprisingly limited” […] because little has been done to “change the essential quality of the academic experience for most students, especially during the critical first year of college” (Tinto, 2001, p. 1).

It is important not to confuse retention with the number of students who remain in college. Tinto (2001) frames retention not by the number of students who remain in college, but those who “acquire the knowledge and skills needed for participation in society” (p. 3) and graduate. Retention has become a nationwide higher education focus (Tinto, 2001). Although some students successfully persist in college, more than half of
them decide to withdraw for various reasons. To help understand the main reasons students withdraw from college, Tinto (2001) identifies seven major causes:

1. Academic difficulty: students’ insufficient academic skills result in the inability to meet the standards of the university or college.

2. Adjustment difficulties: some students have difficulty adjusting to college because they enter unprepared or they come from backgrounds different from most of their classmates.

3. Goals: many students enter college with little to no career goals, which causes them to have an undecided mindset. This undecided mindset only prolongs their journey towards a degree, causes students to struggle to persist, and makes obtaining a degree more challenging.

4. Commitments: students have the ability to do college-level work, but lack the commitment to do so. Personal commitments cause students who would normally stay in school to stop-out and return at a later date.

5. Finances: many students, particularly low-income, working class or from disadvantaged backgrounds, leave due to direct and indirect costs of college attendance. As a result, some students leave and never return.

6. Fit: some students permanently withdraw from college because they lack the ability to establish connections with classmates or campus personnel and/or they feel that college is “not right” for them. While others decide to transfer to another institution because they are bored or unchallenged intellectually.

7. Learning: learning predicts student persistence. If students feel that they are not learning, then they will either dropout, stop-out, or completely withdraw.
from college. However, students will value their education by remaining in college if they feel that they are learning.

Unfortunately, retention programs are seen as insufficient because they lack the ability to change students’ academic experiences on a regular and long-term basis. In order to promote change in these programs one must be willing to understand the very thing that they are trying to change--namely, student persistence and success. To effectively help students persist, students’ voices, along with faculty involvement, should be part of the change process. This implies that students, faculty, and administrators should actively participate and advocate for student learning and persistence. Tinto (2001) states “the best retention program is always a strong academic program that actively involves students in learning, especially with others” (p. 3). To help create the best retention program, institutions have incorporated remedial (or developmental) courses, tutorials, and supplemental instruction activities to enhance the academic skills of students (Tinto, 2001).

According to Solórzano, Datnow, Park, and Watford (2013), “in order to foster students’ postsecondary success, we need an understanding of the multiple ways low-income young adults successfully move through Postsecondary Education (PSE)” (p. 34). Equally important, is understanding how to use students’ K-12 knowledge and skills, or lack thereof, to help them navigate through the developmental education pipeline and prepare them for degrees that benefit them (Solórzano et al., 2013). Solórzano and colleagues (2013) note that, “Youth from low-income families are far less likely to complete college preparatory coursework,” but when they do “they enroll into four-year institutions at high rates” (p. 34). These researchers also discovered that the complicated
reality of persistence and retention in community colleges is students’ often non-linear pathways toward their certificate or degree. As a result, they “often had trajectories that contained remedial loops, stop-outs (taking breaks from school), and participation in multiple curricular pathways” (Solórzano et al., 2013, p. 40). Figure 1 shows an example of what a non-linear pathway through community college could look like.

This figure shows how students who aspire to obtain a bachelor’s degree upon enrollment in community college often find themselves facing challenges and hurdles that interfere with these goals. Multiple pathway choices between certificates and degrees provided by the college combine with poor K-12 experience, high numbers of required developmental courses, financial stresses, feelings of unpreparedness, and personal situations, to push students to stop-out or eventually drop out of college altogether (Solórzano et al., 2013). According to Solórzano and colleagues, students’ initial placement level can require them to take up to an additional two and a half years of developmental education or basic skills classes prior to beginning college-ready courses.
As a result, “whenever enrollment occurs, it can create a type of loop in progress, where a student spends a large segment of his or her community college pathway building college readiness skills instead of taking college-level curricula” (Solórzano et al., 2013, p. 42). Consequently, students feel like the only options are to stop-out and work or completely drop out because the costs for staying in this college loop far outweigh the costs to stop-out or leave altogether.

**Community College Developmental Education**

One of the major contributors to college dropout is the fact few students successfully enter community college prepared to engage in college-level mathematics classes. Placement levels are determined by placement exams, typically selected by mathematics faculty at each community college. Placement in developmental mathematics classes at the two-year college, however, can be crippling because those classes are not transferrable to a four-year university. As a result, students who place into developmental mathematics can spend “a large segment of [their] community college pathway building college readiness skills instead of taking college-level curricula” (Solórzano et al., 2013, p. 42). Research has shown that for every developmental math course that students take, the chances of their completing a certificate or degree in their college drops by approximately 22% (Moore & Shulock, 2010). Students who end up with three or more courses below transferrable mathematics could conceivably be stuck at a two-year college for three to five years before transferring to a university. For many, the math becomes too much, and they never successfully complete or transfer.

Developmental mathematics at the community college level is one of the most challenging leaks in the mathematics K-20 pipeline. Numerous studies document the
difficulties that students, particularly those from disadvantaged educational and income backgrounds, have in completing both high school math courses as well as the developmental math courses in which they place in college (Betts, Zau, & Bachofer, 2013; Moore & Shulock, 2010). Much of this coursework includes mathematics that students should have completed in high school, if they completed their diploma, as the curriculum in college developmental courses overlaps with high school mathematics topics from basic mathematics (adding and subtracting) to “second-year” high school algebra, also known as Intermediate Algebra or Algebra II. Once students pass their developmental mathematics gatekeeper course at college, they are allowed to move on to college-level math beginning with pre-calculus and statistics and then on to other advanced math coursework.

Prior to walking into the college classroom, students have preconceived notions of what it means to be a community college student. One way to find out how students conceive of college is to ask them. Students who are unsuccessful in their remedial math courses can provide insight into how we can help build strategies to maximize their learning and success in these courses. Otherwise, the curriculum, instructional strategies, and policies will continue to under-serve the under-prepared. If the goal of developmental education is to provide students with the necessary skills for obtaining access, and successfully completing college-level courses and academic programs, then decisions need to be made with students’ learning needs in mind. Trying to change the cultural stigma of developmental mathematics without seeking to understand the lived experiences and learning needs of that culture results in a cycle of missed opportunities to actually make a difference.
Although there exists a substantial amount of research on developmental mathematics, the research primarily explains that the majority of students who take developmental math are first-time freshmen, low-income, over-represented students of color. Moreover, these students are also less likely to remediate successfully (Attewell, Lavin, Domina, and Levey, 2006; Bailey, 2009; Bahr, 2010; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013; Solórzano et al., 2013). This research is focused primarily on identifying the characteristics of students in developmental mathematics and reveals little about their experience in developmental mathematics courses.

**Purpose of the Study and Research Questions**

Despite the amount of research on developmental math, little is known about the learning needs as expressed by students, the views of student learning needs by faculty, and the ways that instructional practices address those needs. This gap in knowledge will be addressed by this study. The goal is to understand the situation, from students’ perspectives, and to identify the necessary resources and strategies for maximizing students’ success in developmental mathematics classes. This study is guided by the following research questions:

1. How do community college students characterize their needs and learning experiences in an accelerated developmental math class?
2. How do instructors characterize the learning needs of their students within an accelerated developmental math class?
3. What instructional practices do the instructors use to meet the learning needs of their students?
4. In what ways do the instructional practices in an accelerated developmental math course match the learning needs of their students?

This study was guided by theory and research based on an ecological model, constructivism, zone of proximal development (ZPD), scaffolding and discourse, and mindsets. These questions were addressed using a qualitative method approach. To better understand how faculty and students characterize learning needs of students in developmental mathematics classes, this study focused specifically on faculty and students who were in the three Math 46 courses during the summer of 2015 offered at the same community college. The three classes had an average of 24 students in each class for a total of 73 enrolled students, and 37 students along with the three professors volunteered to participate in the study. Of the 37 students who were initially surveyed, seventeen students agreed to participate in semi-structured or focus group interviews. All three professors agreed to participate in semi-structured interviews. Data was triangulated via field note observations, surveys, semi-structured interviews, and focus group interviews.

This study is nested within a larger study; which co-designed, implemented, and studied targeted accelerated developmental mathematics courses in an urban community college to help create and improve the developmental math experience. This atypical model of instruction used in-class tutors to not only help professors and students address gaps in students’ mathematical knowledge, but also to assist students to move with greater precision and confidence through the mathematics. The courses featured mandated tutoring, low teacher-to-student ratios, and the right-to-accelerate. Although a part of a larger study, the heart of the present study centered on examining the
perspectives and voices of students enrolled in these targeted Math 46 courses, a combination of Elementary Algebra and Geometry, as well as insights from the professors who taught these courses. Moreover, this study sought to understand strategies for maximizing students’ success in developmental math classes and the interactions between students’ social and physical environments that mediate their thinking and understanding of developmental mathematics.

**Dissertation Organization and Overview**

Chapter 2 introduces the current research in the field of developmental mathematics. In this chapter, I first talk about community college developmental education followed by community college developmental mathematics specifically. In addition, I review key research in the theoretical frameworks in which I embed in this study, including Bronfenbrenner’s Ecological Model, Social Constructivism, Scaffolding, Discourse, and Mindsets.

Chapter 3 explains the qualitative research design used to conduct this study. I briefly discuss my positionality as the study investigator as well as limitations of the study. This chapter also includes information about participant selection criteria, data collection, and analysis procedures.

Chapter 4 provides an analysis of study findings. I address and answer the research questions by examining survey and interview transcript responses about how students characterize their learning needs and experiences in developmental mathematics. I utilize the voices of students and faculty to fully address and understand what students need in order to be successful in developmental mathematics.
In Chapter 5, I offer a synopsis of the study’s goals and findings in relation to current research and theory. I also discuss implications for institutional policy and practices, community college, and high school district leaders. Finally, I conclude with recommendations for future research.
Chapter II: Review of Literature

Overview

To lay a foundation for this study, this review of literature will address topics that help better understand factors that contribute to students’ experiences in developmental math classes. The review of research, which ranges from 1977-2013, focuses on community college developmental education in general, community college developmental math education, and the effectiveness of community college mathematics remediation.

Community College Developmental Education

In the 17th century, Harvard College provided tutors for students who were underprepared (Aycaster, 2001). This was the first sign of remediation, which still exists today. According to Fong, Melguizo, Prather, and Bos (2013), “developmental education is increasingly declared a broken system” (p.1). “Students who begin at a developmental level Math or English have less than 25% chance of attaining an associate’s degree within 8 years, and only 33% complete their developmental math sequence” (Bailey, 2009, p. 259; Bailey, Jeong, and Cho, 2010, p. 14). Fong and colleagues (2013) also examined the Complete College America (CCA, 2012) report. They found that “only 22% of students who were referred into remedial Math or English programs completed their transfer-level “gatekeeper” course within two years (Fong et al., 2013, p.1). Additionally, “only 16% of those students required to take 3 developmental math courses completed their full sequence within three years” (Fong et al., 2013, p.1).

According to Oudenhoven (2002), more than half of students who need developmental education are recent high school graduates. Bailey et al. (2009) found that
many college students, particularly high school graduates, are “surprised and discouraged when they learn that they must delay their college education and in effect return to high school” (p. 257). Solórzano, Acevedo-Gil, and Santos (2013) note that many community college students are “underprepared” or need “developmental education”, or “remediation” in the content areas of Mathematics and English. Lewis (1996) explains that remedial education courses in reading, writing, or mathematics were designed for students who entered college unprepared to perform college-level work as defined by the individual institution.

The goal of developmental education is to provide students with the necessary skills for not only obtaining access, but also successfully completing college-level courses and academic programs (Weissman, Bulakowski, and Jumisko, 1997). For this reason, “concerns about access have been the driving force behind many of the education policies developed at federal, state, and local levels” (Weissman et al., 1997, p. 73). Just as educators faced challenges with respect to providing additional support to students accepted into Harvard in the 1600s, colleges’ still face challenges with providing adequate support for students who are currently underprepared. In their attempt to tackle such challenge, colleges place students into developmental classes based on how they perform on their Mathematics and English placement exams (Solórzano et al., 2013, p. 3). Minority and low-income students are over-represented in these remedial classes. Additionally, college-level courses are designed for students to earn credit, but the developmental math credits are not transferable to four-year institutions. Transfer-level courses are designed for community college students to not only earn credits, but also transfer those credits to four-year institutions.
Community College Developmental Mathematics

Many studies on developmental math education focus on first-time college freshmen (Bahr, 2008; Bahr, 2010; Berenson, Carter, and Norwood, 1992; Fong, Melguizo, Prather, and Bos, 2013; Hagedorn, Siadat, Fogel, Nora, and Pascarella, 1999; Hall and Ponton, 2005; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013). Moreover, most studies find a multitude of students of color in remedial/developmental math classes. For example, Attewell, Lavin, Domina, and Levey (2006) analyzed data from students’ transcripts from the National Educational Longitudinal Study (NELS: 88) of community colleges and 4-year institutions to help create a picture of developmental education. They found that more Black students take remedial courses, compared to non-Hispanic White students (61% vs. 35%, respectively). Harwell, Post, Medhanie, Dupuis, and LeBeau (2013) observed while conducting their study on high school mathematics curricula and college math achievement that the academic achievement gap between Black and white students still exists in college.

In an attempt to answer possible reasons why first-time freshman place into developmental math classes, Oudenhoven (2002) explains “those who need remediation may be rusty or may have never learned the information the first time around” (p. 39). Although Mathematics and English are required remedial courses, “the lack of mathematics success may contribute to an at-risk student’s decision to drop out of college” (Berenson, Carter, and Norwood, 1992, p. 55). Berenson and colleagues (1992) conducted a two-part study to identify factors contributing to how well college freshmen performed in remedial math classes. They observed that math placement is the predictor
of college completion for entering freshmen. As a result, students should be identified as “at-risk” if they are required to take remedial math classes.

Developmental Mathematics: Does It Work? And How Does It Work?

Fong and colleagues (2013) analyzed transcript data from students who attended the Los Angeles Community College District (LACCD) between summer 2005 and spring 2008. After analyzing the percentages of students passing each level of the developmental mathematics trajectory based on initial placement, the authors discovered that little more than half of students who were initially placed into Intermediate Algebra actually completed the course. The authors also noted that the percentage of students who were placed in the lowest developmental course (Arithmetic) and worked their way up to the highest level course (Intermediate Algebra) performed at rates comparable to those students who initially started with Intermediate Algebra. Clearly, remediation in developmental math courses is beneficial to students’ success for those who actually remediate successfully. However, developmental math courses can be discouraging for the large portion of students who do not remediate successfully. The factors that contribute to unsuccessful remediation include, but are not limited to: limited support or resources, past experiences in mathematics, financial hardships, talking care of family, job related obligations, and the length of the developmental math sequence itself (Fong et. al, 2013). Unsuccessful remediate causes students to not only stop out, but also potentially drop out of college altogether. As a result, there is room for improvement in remedial/developmental mathematics.

Bahr (2008) conducted a study that tested the efficacy of remedial math programs. He did this by comparing students who remediated successfully versus those who do not
need remediation. Bahr (2008) found that successful remediation results in long-term success. In addition, Bahr (2008) uncovered that “students who remEDIATE successfully experience outcomes that were effectively equivalent to those of students who do not require remediation” (p. 421). Although remediation works for those who remEDIATE successfully, unsuccessful remediation results in barriers to success, potentially dropping out. This should be evident. However, what is not evident are factors hindering students from remediating. In an attempt to answer why remediation works for some and not others, Bahr (2008) notes that “grade[s] in first math class, depth of remedial need at college entry, and breadth of remedial need[ed] at college entry” are all predictors of why some students remEDIATE successfully while the majority remEDIATE unsuccessfully (p. 444).

Bahr (2010) conducted a study that included first-time freshmen from the fall of 1995 through the spring of 2001. This study focused on comparing long-term outcomes of 85,894 first-time freshmen from 107 community colleges. The author focused on community college remediation to explore racial/ethnic group differences, how well these groups benefit from remediation, and whether the benefits are similar among the different ethnic groups. Bahr (2010) observed “Blacks and Hispanics face significant disadvantages in the likelihood of successful remediation”, which causes them to transfer prior to obtaining a degree or certificate (p. 227). This implies that students of color are not passing or finishing the required number of courses to received a certificate or degree. As a result, some are not getting into 4-year colleges. Transferring to a 4-year institution is impossible without passing developmental math because such courses are required prior to taking some required college-ready courses. If students are not remediating
successfully, then they lose their opportunity to persist in college. Students of color are not passing their remedial classes. The result of not passing hinders them from obtaining a degree or certificate at a community college and limits their chances of being able to transfer to a 4-year institution and obtain a bachelor’s degree. Students are, in a sense, stuck in a developmental math disaster. If students are not remediating successfully, then they lose their opportunity to persist in college, obtain a certificate or degree, and pursue their lifelong dreams.

In sum, after reviewing the research on community college developmental math education, it is evident that math placement predicts college success and makes it less possible for students to graduate. Second, the lower students place in developmental courses the longer it takes for them to finish their sequence. Third, taking a remedial course and passing does not guarantee that one will be successful in their next course or remaining courses. Finally, students who pass their remedial courses are not guaranteed the same success as students who place directly into their transfer-level course.

Though a wide variety of students take developmental math, most of them are first-time freshmen. Studies find a majority of low income, students of color in remedial classes. Students of color are overrepresented in developmental math classes, and they are less likely to remediate successfully (Bahr, 2010). It may be the case that students of color are underprepared because they attend under resourced schools in elementary, middle, and high school. Passing developmental math places students at the same level as those who do not need remediation. Although it is clear that remediation works for those who remediate successfully, it is still unclear what factors that contribute to students’ inability to successfully remediate, reasons why developmental math courses only work
for some students, the type of supports offered to students, and the types of supports that are most promising for underprepared students.

The uniqueness of education is that we all learn in many different ways; thus, we all think and succeed in many different ways. Equally, learning in many different ways implies teachers will have to teach using meaningful interactions that must include an in-depth understanding of the student’s prior knowledge combined with “purposes of the immediate task and the teaching strategies needed to move individuals on” to expand and deepen their level of thinking and understanding (Anghileri, 2006, pg. 37). Several learning perspectives have emerged in mathematics education. These perspectives are important because they have contrasting views about how students learn and whether or not they help further students’ conceptual understanding. Among these theoretical perspectives lies social constructivism, which addresses how students think, discuss, and learn inside the classroom.

**Constructivism**

Constructivism is not a specific pedagogy; however, it can be described as “a theory about the limits of human knowledge with a belief that all knowledge is a product of our own cognitive acts” (Confrey, 1990, pg. 108). The reason for this is simply because the experiences we encounter pave the way for the knowledge we construct and build upon. von Glasersfeld (1989) explicates that knowledge is not passively received; rather it is built up actively. Thus, in order to actively build up knowledge students must be engaged in “pedagogical approaches that allow students to connect to each other, their teachers, and the real world, and also to make connections between their prior knowledge and new knowledge” (Azzarito and Ennis, 2003, pg. 181). Although students collaborate
with others, they construct the sense they make from the collaboration on their own. As a result, “much of what we learn involves making new interpretations that enable us to elaborate, further differentiate, and reinforce our long-established frames of reference or to create new meaning schemes. In addition, the process of reflecting back on prior learning to determine whether what we have learned is justified under present circumstances” (Mezirow, 1990, pg. 3). It is crucial that students are given the opportunity to build on their prior knowledge, past experiences, collaborate with others, and individually express their thinking and learning process in order for them to construct and build upon knew knowledge. Since learning is social, students need to talk and collaborate about the mathematics in which they are learning.

Social Constructivism

Kalina and Powell (2009) note that social constructivism consists of both collaboration and social interaction. Kalina and Powell write that all students can benefit from the social constructivist teaching style because it requires students to critically think and socially interact with their peers. This suggests that the social interaction would be a deviation from the traditional approach of the teacher as the center of attention. Bayer (1990) indicates that the use of language and thinking allows students to use language via speaking and writing as vehicles for learning. Instead of the teacher doing most of the instructing, talking, and asking questions, this social interaction would cause the roles between teachers and students to switch. Therefore, the use of effective collaboration and social interaction requires teachers to engage students through questioning, exploring, discussing, and reflecting with others, all of which make the learning more meaningful.
Cooperative Learning

Vygotsky (1986) suggests many theories that fall under the social constructivism umbrella and are effective in the classroom. Among these theories is cooperative learning. Kushnir (2001) affirms that we are living in a new era that requires more analyzing and communication in the real world. Current jobs require that we as citizens know how to effectively analyze, communicate, and work well with others. There is no way around being able to socialize with others because employees today “work in teams to generate data, solve problems, and develop strategies for success…and develop higher order thinking skills” (Kushnir, 2001, p. 6). Thus, students must have experiences with these necessary skills to succeed early in life in order to be ready for the world that awaits them. The sooner students are introduced to the various cooperative learning strategies the better off they will be in their academic achievement and the real world.

Most people would expect students to get their social communication skills from home, but that is not the case in many homes. Kushnir (2001) suggests that many students come from broken homes. Students often do not communicate effectively with their parent(s) because they barely see or talk to them due to work and school schedules. We live in a technological era, where we may text more than we talk or see our family and friends. Since students are not having much conversation with their parents at home, they turn to things that will always be at home when they arrive, such a television or social media. No matter the time or day, students always have access to a television or social media. Just because students have access to these things, it does not mean they obtaining proper access to learning how to communicate effectively. If fact, Kushnir (2001) posit that materials such as a television or social media minimize necessary
contact and guidance from parents. As a result, TV and social media are destructively shaping and molding young people, as well as serving as role models. Students are constantly “exposed to violent, racist, or overtly sexual content” (Kushnir, 2001, p. 6). If we want the negative feedback students are getting from TV and social media not to affect them, then we need to make a change inside the classroom because that is where students spend most of their time. TV and social media are not helping students positively with their language, thought, social communication skills, and critical thinking skills necessary for cooperative learning and success in school.

Kalina and Powell (2009) declare that cooperative learning helps with thought, social communication skills, and critical thinking skills, all of which create a social constructivist classroom because it alters the learning from focusing solely on teacher-to-student interaction to focusing on the student-to-student interaction. Likewise, Kushnir (2001) explains that cooperative learning helps students develop “wider social skills, become more willing to help and praise others when problem solving, and enjoy improved relationships between races” (p. 6). Additionally, cooperative learning, compared to traditional teacher-centered teaching, produces higher academic achievement for students who are struggling as well as for high achieving students (Kushnir, 2001).

McInerney and Roberts (2004) explain that cooperative learning removes the teacher from being the center of attention to facilitating student-to-student interaction via small groups. This student-to-student interaction will help students develop thought processes necessary to be able to explain, understand, and justify their reasoning. When students work together in groups the focus shifts from the individual student as a learner
to students working together. The more students work together to help each other learn, the greater their chances are to develop their language and thought, strengthen their critical thinking skills, and better understand the problems they solve.

According to Vygotsky (1986), “a thought is not merely expressed in words; it comes into existence through them (students)” (p. 218). This implies that students need to begin speaking about the mathematics they are learning in order to understand what they are learning. Traditionally, students are rarely asked to explain their reasoning for solving a particular problem. If they are asked to explain, they just read verbatim the steps they used to solve the problem. This does not help students with understanding their own thinking and learning process because they think they know how to solve a problem simply because they saw a replica of their problem solved by the teacher. The more they collaborate and critically think about the mathematics, the more students come to realize what they do and do not know about the mathematics. Vygotsky (1986) further explains that the relationship between thought and word is a continual process that moves back and forth and undergoes changes because “every thought moves, grows and develops, fulfills a function, and solves a problem” (p. 218). As a result, collaboration needs to continue over time. In order for this to happen, teachers need to implement writing and collaboration activities on a daily basis. We cannot expect student to automatically know how to explain and justify their reasoning if they are not given the chance to successfully go through the process.

**Scaffolding and Discourse**

Once students’ prior knowledge has been assessed, teachers can begin to build on it via scaffolding. Scaffolding, a term coined by Jerome Bruner in the late 1950’s, is “the
temporary use of instructional support that provides the learner ease of access to the targeted zones of the subject matter until it becomes internalized” (Lake, 2012, p. 53). Scaffolding is vital and needs to be implemented because it helps students find an entry point to what the teacher wants students to know. In addition, it helps students actively build and construct new knowledge without telling them exactly how to complete the task.

An effective way of ensuring that scaffolding and discourse is successful inside the classroom is by using Vygotsky’s Zone of Proximal Development (ZPD) principle (Bayer, 1990). According to Vygotsky (1978), applying the ZPD implies that students start with what they know and apply it to a task that they can do with others (more capable peers) today; then later, they will be able to individually perform that task. This notion of providing temporary support until the student can stand-alone can be used through differentiated instruction, which consists of students engaging in the same task with varying levels of support. Tomlinson (2008) affirms that differentiated instruction helps maximize the potential of all learners by enabling teachers to help students on an individual level because they are meeting individual needs of students. Thus, a safe environment is created, making students comfortable enough to discuss, justify, share, and explain their reasoning. Additionally, it is through differentiated instruction that students are allowed to have access to various levels of assisted learning. The best part about the activities used for this type of instruction is the fact that activities can be modified for individual learner needs.

This is important because being able to perform above one’s ability level of development, one must engage in activities with teachers or peers that are more capable.
It is impossible for a student to increase her or his level of development individually because, according to Vygotsky, learning is social and students cannot co-construct meaning or increase their level of understanding of the content without first engaging in joint activities, which stimulates their conceptual understanding and development.

**Classroom Environment**

Silver and Smith (1996) notes that traditional mathematics instruction is teacher-centered. This teaching style consists of teachers telling while students listen and work in isolation with little to no student-to-student interaction. Although teachers want to incorporate discourse inside the classroom, the reality is most teachers do not. The reason the implementation of discourse continues to be a challenge is because it is “a complex, multifaceted undertaking” (Silver and Smith, 1996, p. 21). This may help explain why most teachers stick to the basics and teach the way they were taught, which may be the opposite of how they really want to teach. They are merely staying in their comfort zone because they do not want to face the challenges of, what Silver and Smith would see as, traveling different pathways to ensure discourse is successful or knowing what to do when they hit a road block. Before students can think about challenges they will face, it is necessary to take a step back to determine effective ways of initiating the discourse.

Silver and Smith make it clear that teachers must ensure that students feel safe and comfortable enough to speak in the classroom. This does not have to be about the content specifically because students will be reluctant to engage in normal conversation with a peer if they are uncomfortable. They need to feel safe enough to be able to ask questions and justify their reasoning without the fear of a classmate or teacher making them feel like their opinions are, what Silver and Stone would classify as “dumb” or “stupid.”
Thus, the classroom must be “safe for thinking and speaking” in order to get basic discourse started (Silver and Smith, 1996, p. 22). Once students feel safe, their confidence will build and it will be easier for them to engage in discourse centered on discussing and justifying their reasoning about the content.

Once teachers are successful in ensuring that students feel safe enough to think and speak in the classroom, they need to ensure that the task that they select for promoting discourse not only engage but also challenge students. Silver and Smith (1996) suggests that selecting a demanding task does not imply that the discourse will engage and challenge students. A disconnection between the selected task and questions used to promote the discourse occurs when students are limited from engaging in rich discourse, which is classified as typical occurring in a traditional mathematics classroom (Silver and Smith, 1996). It is important that the questions asked are demanding enough for the task presented to ensure discussions beyond “giving and telling” of answers or asking questions that only arrive at one solution method because what once could appear as a rich discussion can turn into a typical traditional way of promoting student discourse, which is not sufficient enough to effectively engage students. Unfortunately, many teachers lack the necessary experience in incorporating student discourse. Consequently, they stick to how they were taught, confined teaching, and the stand-and-deliver approach; this is the traditional way of teaching. Such lack of experience puts teachers and students at the same disadvantage when trying to initiate rich discourse. Both teachers and students lack experience on both ends of the spectrum, which is promoting and initiating discourse. Both teachers and students need to feel safe and comfortable
before they can be successful with staying on the discourse journey, which allows students to think about and effectively discuss the mathematics they are learning.

**Metacognition**

According to Gourgey (1998), metacognition consists of internal processes that help students think about their learning process, know when and what they do or do not understand, determine what tools are necessary for solving a problem, and decide how to monitor and improve their grades. Schoenfeld (1987) writes that students have poor metacognitive skills primarily because they lack the ability to make sure their solution strategy is correct prior to arriving at an answer. Gourgey (1998) reports this lack of ability leads to a series of “impulsive and illogical attempts at a solution” (Gourgey, 1998, p. 87). Consequently, students struggle with connecting what they do in the classroom to the world around them. Hence, students instantly try to solve problems without thinking or understanding what the problem is asking them to do. The result is incorrect answers that do not make sense. The following example comes from the *Metacognition in Basic Skills Instruction* article:
The Problem: Old Farmhouse
I’ve just bought an old farmhouse and want to renovate it for a home. There’s an old well on the property, about 20 feet in circumference and more than 20 feet deep. There’s no water in it, but it’s still dangerous, particularly to my pets. So I want to make a square wooden cover for it. I’m advised to get standard thickness 1" by 6" treated lumber for all of the construction: several planks will go across the top of the well, reinforced by two crosswise pieces and one plank across the diagonal. There will be some wastage, because I can’t piece together small pieces of wood for the construction.

The lumber comes in three lengths: 8’ @ $ 9.00 a piece
10’ @ $ 10.50
12’ @ $ 12.00

– What will be the exact dimensions of the cover?
– How much will the lumber cost?

Figure 2: Sample Example Problem from the Metacognition in Basic Skills article

Immediately following this problem were questions that students could use to help ensure that they knew what the problem was asking them to do, check if they were on the right track, and check if their answers were reasonable. Although students were given these helpful guiding questions, Gourgey (1998) observed that students immediately jumped to calculating. In fact, she had to draw their attention to the question given in order for some of the students to slow down and think about what they were doing. In doing this, she was able to slow down their calculating process, cause some students to look to their peers for support, and become puzzled on what they were actually looking for in the problem. The researcher found that although students were frustrated and began to complain about the metacognitive process of problem solving, they were able to solve the problem with confidence in knowing why and how they arrived at their solutions. Gourgey (1998) explains that practice and encouragement are both required when helping students think metacognitively. Furthermore, those students
who carry out the metacognitive strategies effectively are more successful than those who do not use them. Gourgey further explains that students who do not use metacognitive strategies are capable of doing so, but they are not used to that way of thinking. As a result, students end up going on what Schoenfeld would classify as a “wild goose chase” (Gourgey, 1998). Instead of students using their time to solve a problem, they could utilize that time to stop, think, and check to see if they are on the right track or if what they are doing makes sense. To help with this process, students need scaffolded instruction to help them feel comfortable with the extra effort that is required to think metacognitively.

Pugalee (2001) writes that metacognition is the process of monitoring one’s mental activities, which helps students retain the necessary information needed for effective problem solving. Pugalee conducted a study in a high school algebra class of 20 students that focused on discovering whether students’ metacognitive behaviors stemmed from their writing. Pugalee used Garofalo and Lester’s (1985) four phases of problem solving (orientation, organization, execution, and verification) to help monitor and evaluate student’s metacognitive behaviors. The orientation phase incorporates assessing and understanding the problem. The organization phase, once a student understands the problem, leads to plans for solving the problem. The execution phase includes performance of goals and calculations. The verification phase involves evaluating decisions and results. Students were given six problems to solve, but prior to this, they wrote weekly over a three-month period about how they arrived at their solutions for various problems. Students were required to record every thought while solving the problems. Pugalee found that students’ demonstrated mathematical reasoning via writing
and showed use of metacognitive behaviors in all four of the problem solving phases listed above.

Garofalo and Lester’s (1985) metacognitive problem-solving phases are similar to that of Polya’s “How To Solve It” four-step method. According to Polya (2014), students need to first understand the problem (orientation phase). This is where students self-examine to make sure they know and understand what the problem is asking them to do, check for unknowns, and try to restate the problem a different way. Second, students must devise a plan for solving (organization phase). Here, students can use diagrams and lists, look for patterns, and decompose the problem. Third, students must carry out their plan (execution phase). This is where students spend time working out the problem based on their proposed plan. If they are having trouble, then it is suggested that they go back to step 2. If returning back to step 2 is not helping students, then they should go back to the first step. Finally, if that does not work, then they should consult with a peer. Fourth, students must look back to examine their solution (verification phase). This can only occur if students were successful completing steps 1-3. During this step, students should check to see if their answers are reasonable.

For the purpose of this study, metacognition and mindsets play a critical in how students seek to understand and characterize their needs and learning experiences. In order for students to be able to characterize their learning needs they need to know the type of supports and resources they need to effectively learn. Additionally, they need to be able to think about their own thinking and learning process in order to engage in practice and effective collaboration with their classmates Gourgey (1998). Furthermore, those students who carry out the metacognitive strategies effectively are more successful
than those who do not use them. In addition to carrying out metacognitive strategies, students need to ensure that they understand what is expected of them in order to persist through the developmental math pipeline. If students are not aware of the requirements of the developmental math program, then they will not know what it takes to successfully persist through the developmental math pipeline, be eligible to take college-level courses, obtain a degree or certificate, and/or transfer to a 4-year institution. Moreover, they will not know which college personnel to contact in order to obtain additional information regarding the above requirements.

Thinking about their learning process as a college student in general and as a student in a specific course should always be a part of a student’s metacognitive process. However, students should not be expected to navigate through college and understand what is expected of them on their own. Students transition from high school to college with numerous supports that were automatically offered to them once they entered high school. College, on the other hand, does not operate in the same way that high schools function. For this reason, students need supports as they try to gain knowledge about the new expectations that they must meet in order to successful as college students as well as trying to understand what they need to learn in their new institution.

**Problem Solving**

Scharton (2004) notes that knowledge and computational flexibility will grow as students are given the opportunity to not only solve problems, but also communicate their problem solving strategies. Students need the opportunity to express and compare their reasoning with peers because communication is a vehicle that students can use to make necessary connections that increase their level of understanding. If students are only
given the opportunity to solve problems without being able to communicate them, then they are being expected to try to remember and recreate what the teacher told them about solving problems.

For example, Scharton (2004) compared the difference between students who were given more traditional instruction on arithmetic to those students who were given the opportunity to use their own methods for solving problems. Scharton worked with a 1st grader, John, whose teacher showed the procedure first and then allowed the class to practice it. Scharton gave John the following problem:

“Paul had 28 markers. He got 34 more. How many did he have?”

**Figure 3: Sample Example Problem from the Article**

Although John had learned the procedure in class, he was confused about what he had learned. As a result, he forgot what to do and just gave up on trying to solve the problem completely. Most, if not all, teachers using the traditional method only allow time for the material to be taught and students to practice what they just learned in isolation. There is little to no teacher-to-student or student-to-student communication, so students are forced to just write what they saw the teacher write without getting clarity on how or why the problem was solved in a particular way. Scharton says that confusion arises when students use memorized procedures without any understanding of why those procedures work. In John’s case, he had no idea what he was doing to the point that he could not recall the steps needed to add 28 and 34. This lack of understanding and applying place value caused him to lose confidence, which resulted in his giving up. Scharton further explains that John would have been forced to rely on his understanding
of numbers and operations if he had constructed a method of his own. Instead, he was forced to rely on the confusing method of his teacher.

Scharton worked with another student, Melissa, who came from a class that allowed students to create and share their own methods for problem solving. Scharton found that Melissa’s work demonstrated that she was confident in understanding and applying place value so much that she was able to accurately solve the problem with a detailed explanation of how she arrived at her solution. In addition, unlike John, Melissa’s work demonstrated a higher level of understanding because she was computationally fluent. She understood that each digit in a two-digit number has a different separate value, and she showed an understanding of commutative and associative properties of addition, which allow one to add addends in any order without changing their sum. If the grouping of the addends is changed, their sum will also remain the same (Scharton, 2004).

After working with both of these students, Scharton suggests that students who are given the opportunity to communicate the problems they solve are better prepared to understand reason for solving problems the way they need to be solved. In addition, students can understand and develop a method for solving on their own in which they can fully explain and justify their reasoning. Students who develop a conceptual understanding of the problems they solve use their understanding to solve problems with “accuracy, efficiency, and flexibility, which forces them to make sense of what they are doing and understand their own methods and deepen other students’ understandings” (Scharton, 2004, p. 282).
It is important to note that prior knowledge involves more than just knowledge of the content. Educators have to take into account that prior knowledge also consists of students’ cultural and social backgrounds, as well as interests they acquire outside the classroom. Teachers cannot help all students develop the necessary understanding and problem-solving skills if we are not looking at each individual student as a whole. Learning the content is important, but equally important is learning about our students and their cultural backgrounds because there might be connections to how students solve problems, answer questions, or ask questions the way they do. Every aspect of the individual student helps shape the student. The use of discourse, metacognition, cooperative learning, and problem solving will not only help extend, but also deepen the level of thinking and understanding for all students. In addition, students develop their voices by being able to discuss, justify, explain, and reason mathematically with others.

**Mindset**

Before students can develop their own voice, they have to believe that they have one valuable enough to be heard. Additionally, students have to believe that they can actually do the mathematics expected despite their past struggles with mathematics. Past experiences and/or challenges have an affect on a person’s mindset about their future abilities and success. According to Dweck (2009), “mindsets can be fairly stable, but they are beliefs, and beliefs can be changed” (p. 2). As a result, a person can go from a fixed to a growth mindset. According to Yeager and Dweck (2012), a person with a fixed mindset believes that there is no hope in changing their academic underachievement or challenges as a result of past struggles or experiences. Hence, students believe that their intelligence fixed. This type of thinking causes students to “feel ‘dumb’ or be seen as
‘dumb’, which compromises resilience in academic settings” (p. 302). A student with a growth mindset, on the other hand, believes that there is hope in improving their academic underachievement or challenges. This mindset promotes resilience (Yeager and Dweck, 2012). Hence, students believe that their intelligence can develop or improve.

According to Yeager and Dweck (2012), “as students move through our educational system, all of them will face adversity at one time or another, whether it is social or academic in nature” (p. 312). What matters most is how one responds to their setbacks. As a result, it is important that students develop a resilient mindset whenever adversity or challenges arise. Many students enter college with their mind made up about their intelligence, which is based on their past experiences and setbacks. Aditomo (2015) reports that “students can respond to such setbacks in more or less productive ways: some feel de-motivated and avoid similar challenges [fixed mindset], while others could feel challenged, evaluate the causes of their setback, and plan strategies to address those problems [growth mindset]” (p. 200). Therefore, the difference between a fixed and growth mindset is how one responds to their challenges or setbacks, which determines their level of resilience. In order to help students develop a resiliency mindset, parents and educators alike must have an understanding of what causes one to overcome challenges and setbacks. It is evident that students need support with more than just their academic coursework upon entering college. Research (Oudenhoven, 2002) states that more than 50% of students place into remedial/developmental mathematics classes in college. Many of students who place into these developmental mathematics classes are first-time freshmen, first-generation, low-income, students of color (Attewell, Lavin, Domina, and Levey, 2006; Bailey, 2009; Bahr, 2010; Harwell, Post, Medhanie, Dupuis,
and LeBeau, 2013; Solórzano et al., 2013). Consequently, students not only enter college underprepared, but also without the proper guidance from home on how to navigate through college. Students can be encouraged by family to attend college, but they cannot be guided on how to persist and take advantage of the necessary resources available for their success if their family members have yet to persist themselves. Moreover, students enter college with various backgrounds and past experiences, which affects their mindsets about their ability to develop their intelligence. In order to help foster a growth mindset, students must believe in their own ability to overcome past challenges in mathematics and grow their intelligence, feel safe and comfortable to justify their reasoning in class, and supported inside and outside of class.

**Ecological Theory**

Urie Bronfenbrenner’s (1994) Ecological Theory of human development is based on two primary propositions:

1) Proposition #1 (proximal processes): human development occurs through processes of reciprocal immediate environmental interactions that occur regularly between active people, objects, and symbols and the developing person over extended periods of time.

2) Proposition #2 (joint/mutual interactions): Proximal processes that deal with interactions between the developing person and people and/or objects.

According to Bronfenbrenner, these propositions happen within ecological environments. Bronfenbrenner (1977) defines the ecology of human development as “the scientific study of the progressive, mutual accommodation, throughout the life span, between a growing human organism and the changing immediate environments in which
it lives, as this process is affected by relations obtaining within and between these immediate settings, as well as the larger social contexts, both formal and informal, in which the settings are embedded” (p. 514). These ecological environments are envisioned by a set of nested structures, which is similar to a set of concentric circles (Bronfenbrenner, 1977). Within these concentric circles, the innermost circle contains the developing individual. Figure 4 represents a theoretical illustration of this model (Bronfenbrenner, 1977).

![Bronfenbrenner's Ecological Model (1977)](image)

**Figure 4: Bronfenbrenner's Ecological Model (1977)**

Within the set of nested structures, there are four ecological environmental layers that help the developing student as a whole. The first and innermost nested structure is called the microsystem, which has a direct influence on the individual. This direct
influence implies that there is a direct face-to-face interaction between the individual and her/his direct environment, such as interactions with family, church, social economic status, friend, school personnel, professors, classmates, tutors, and workplace. The second nested structure is the mesosystem, which consist of a network of two or more microsystems that contain the individual, such as relations between home and school, home and church, school and the workplace, or home and the workplace. The third nested structure is the exosystem, which consists of networks of direct and indirect influences. Within this ecological layer, these social structures “do not contain the developing person but impinge upon or encompass the immediate setting in which that person is found, and thereby influence, delimit, or even determine what goes on there” (Bronfenbrenner, 1977, p. 515). Within this structure contains mass media, the individual’s school, parent’s workplace, and specialized programs. The fourth and final nested structure is the macrosystem. This outermost structure is comprised of cultural norms such as “the economic, social, legal, and political systems, of which micro-, meso-, and exo-systems are the concrete manifestations” (Bronfenbrenner, 1977, p. 515). These cultural norms “set the pattern for the structures and activities occurring at the concrete level” (Bronfenbrenner, 1977, p. 515). Together, these ecological environmental layers are important because they allow one to look at the individual from a holistic view.

According to Bronfenbrenner (1994) “to understand human development, one must consider the entire ecological system in which growth occurs” (p. 37). My decision to use an ecological model is connected to my desire to understand whether these various systems work together to help and support the developing student in developmental mathematics. In order to effectively promote change we must understand what we are
trying to change. In this case, understanding and improving the transition between high school and community college mathematics requires students’ perceptions of the course and the type of supports they need to be more successful as they persist through their developmental mathematics pipeline. Moreover, listening to the experiences and voices of students in these classes will help to dismantle the social injustices, inequalities, marginalization, and deficit thinking that hold them captive in developmental mathematics. Trying to change the cultural stigma of developmental mathematics without seeking to understand the lived experiences and learning needs of that culture results in a cycle of missed opportunities to actually make a difference.

Theoretical Framework

Bronfenbrenner’s (1977, 1994) Ecological Theory provides a conceptual framework to help the researcher understand how the learning environment of an accelerated math course meets the perceived learning needs of the students. More specifically, to understand how students’ experiences and perspectives interact with the teachers’ perspectives, learning structures, and the structures of the developmental mathematics program. This environment is based on the perceived student needs held by the course instructors. Figure 5 represents a theoretical application of this model to the developmental math student (Bronfenbrenner, 1994).
According to Bronfenbrenner (1994), “the ecological environment is conceived as a set of nested structures […] moving from the innermost level to the outside” (p. 39). The first and innermost nested structure is called the microsystem, which has a direct influence on the developing student. A microsystem, according to Bronfenbrenner (1994), is “a pattern of activities, social roles, and interpersonal relations experienced by the developing person in a given face-to-face setting with particular physical, social, and symbolic features that invite, permit, or inhibit engagement in sustained, progressively more complex interaction with, and activity in, the immediate environment” (p. 39). For the purposes of this study, these direct influences imply that there are direct face-to-face interactions between the developmental math student and her/his direct environments, such as interactions with professors, tutors, and the classroom environment. As a result, the student’s microsystems in this environmental layer fit into three main categories:
professors, tutors, and the classroom environment. The microsystems of professors will focus on the role that the professor plays in the students’ success in an accelerated developmental math class. Within this interaction, the goal is to understand what teachers believe about their students learning needs and how such beliefs relate to the way they create their lessons. In addition, the goal is to see whether there is a match between the instructional practices teachers are using to ensure that the learning needs of their students are being met and what students’ perceive their actual learning needs to be.

Second, the microsystems of tutors will focus on the role that tutors play inside the classroom. There will be two tutors in each classroom everyday. The tutor’s role will be to help students whenever they need assistance. Instead of waiting for the professor to finish lecturing or being afraid to ask questions, students will have the opportunity to receive immediate help and support from college tutors. Finally, the microsystems of the classroom environment will focus on the design, set-up, and layout of the classroom. In addition, the classroom environment will focus on execution of lesson plans, delivery method, student-to-teacher interactions, student-to-tutor interactions, student-to-student interactions, depth of explanations and how they work together to support the learning needs of the students.

The second nested structure is the mesosystem. According to Bronfenbrenner (1993), a mesosystem consists of “the linkages and processes taking place between two or more settings containing the developing person” specifically focusing “on the synergistic effects created by the interaction of developmentally instigative or inhibitory features and processes present in each setting” (p. 22). For participants, the root of mesosystems will stem from the interactions and relations between the microsystems of
professors, tutors, and the classroom environment. The interactions between these various microsystems will help shape the learning experiences of students in the accelerated developmental math class and potentially have a role in matching the learning needs of students. These interactions are critical because they lie at the heart of the students’ decisions about their developmental math class and whether or not they feel that these systems are working together to help support them as they attempt too persist through the developmental mathematics pipeline. Students need to be assured that they have different immediate supports and resources that they can turn to when their interactions with their professor are not enough to be successfully further their thinking, learning, and understanding of mathematics.

The third nested structure is the exosystem, which extends from the mesosystem and consist of networks of direct and indirect influences to the developing student. According to Bronfenbrenner (1993), exosystems involve “linkages and processes taking place between two or more settings, at least one of which does not contain the developing person, but in which events occur that indirectly influence processes within the immediate setting in which the developing person lives” (p. 24). This implies that the social structures within this layer do not include the developing student, but still impacts the student because this structure interacts with his/her immediate setting. The interactions between these various microsystems will help shape and inform expectations of the immediate setting and include but are not limited to the community college community and the developmental mathematics program offered. Within this system lies policy mandates and program requirements that the developing student must fulfill prior
to being eligible to take the next course in their developmental math sequence, take
college-level courses, obtain a degree or certificate, and/or transfer to a 4-year institution.

The fourth and final nested structure is the macrosystem. Bronfenbrenner (1993) defines a macrosystem as the “overarching pattern of micro-, meso-, and exosystems characteristic of a given culture, subculture, or other extended social structure” and refers particularly to the “developmentally instigative belief systems, resources, hazards, lifestyles, opportunity structures, life course options and patterns of social interchange that are embedded in such overarching systems” (p. 25). For the purposes of this study, the outermost structure contains the K-12 system, placement exam, low-income community, economic influence, the board of higher education, and ethnic community culture. These dominant values and beliefs, although not directly connected to the developing student, affect the student because they control all connections within the ecological model. Together, these ecological environmental layers are important because they allow one to look at the developmental math student from a holistic view. My decision to use an ecological model is connected to my desire to understand how classroom interactions, teacher instructional practices, tutor support, and the goals of the developmental math program impact and/or match students learning needs.

**Chapter Summary**

Metacognition, prior knowledge, scaffolding, discourse, problem solving, constructivism, and social constructivism go hand in hand. In order for students to think, reflect, and justify their thinking, they must speak about it and share their ideas with their peers. Conversely, in order to speak about their understanding of the problems they solve, students must have a constructed thought process of how they are going to solve the
problem. The same idea works for problem solving. Problem solving works best when students can construct and discuss their own method for solving. When this occurs, students become responsible for their own thinking, learning, and understanding, which makes it easier for them understand their own methods. Thus, no matter if students get the problem right or wrong, they will be able to understand reasons for doing so and make necessary changes instead of loosing confidence and giving up.
Chapter III: Methodology

Overview

This chapter gives an overview of the purpose, setting, and research design of the study. This qualitative study investigated developmental mathematics, strategies for maximizing students’ success in developmental math classes, and the interactions between students’ social and physical environments that mediate their thinking and understanding of developmental mathematics. The heart of this study centered on examining the perspectives and voices of students enrolled in Math 46 courses, a combination of Elementary Algebra and Geometry, as well as insights from the professors who taught these courses. As a result, multiple methods of data sources (survey, field note observations, focus group interviews, and semi-structured interviews) were used to understand students and professors’ characterizations of developmental mathematics and its role in helping students persist through the developmental mathematics pipeline.

Purpose of Study and Research Questions

The overarching goal of this study was to explore and understand the learning needs as expressed by students, the views of student learning needs by faculty, and the ways that instructional practices address those needs. This study sought to understand professors’ beliefs about their students learning needs, the reasoning behind their lesson planning, and the instructional practices and resources they are using to ensure that the learning needs of their students are being met. This study was part of a larger study, entitled Plugging leaks in the developmental math pipeline in the community college math sequence, for which Dr. Yonezawa was the principal investigator and I was the
graduate student researcher (GSR). The goals of the larger research study were to investigate the implementation and impacts of efforts to prepare community college students for transferable mathematics coursework through accelerated developmental mathematics courses and compare them to a group of students taking traditional, non-accelerated development mathematics courses. While the larger study focused specifically on implementation and impacts of efforts to prepare community college students for transferable mathematics coursework through accelerated developmental mathematics courses, this dissertation focused exclusively on student and teacher characterizations in respect to acceleration developmental mathematics by examining the following research questions:

1. How do community college students characterize their needs and learning experiences in an accelerated developmental math class?

2. How do instructors characterize the learning needs of their students within an accelerated developmental math class?

3. What instructional practices do the instructors use to meet the learning needs of their students?

4. In what ways do the instructional practices in an accelerated developmental math class match the learning needs of their students?

The following table (Table 1) consists of a detailed matrix of my research questions along with the data collection method that corresponds to each research question.
<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Purpose</th>
<th>Sampling</th>
<th>Methods</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>How do community college students characterize their needs and learning experiences in an accelerated developmental math class?</td>
<td>To understand what supports and resources students believe they need to succeed in developmental math classes.</td>
<td>Students</td>
<td>Surveys, Focus Group Interviews, Classroom Observations</td>
<td>Audio Recording, Transcription Coding</td>
</tr>
<tr>
<td>How do instructors characterize the learning needs of their students within an accelerated developmental math class?</td>
<td>To understand what professors believe about their students learning needs. To understand the reasoning behind their lesson plans. Also, to see what instructional practices professors are using to ensure that the learning needs of their students are being met.</td>
<td>Professors</td>
<td>Semi-structured Interviews, Classroom Observations</td>
<td>Audio Recording, Transcription Coding</td>
</tr>
<tr>
<td>In what ways do the instructional practices in an accelerated developmental math class match the learning needs of their students?</td>
<td>To observe the matches and mismatches between expressed student needs and instructional practices. To verify whether or not students and professors arrived at similar perceptions.</td>
<td>Professors, Students</td>
<td>Semi-structured Interviews, Classroom Observations</td>
<td>Audio Recording, Transcription Coding</td>
</tr>
</tbody>
</table>

Table 1: A Matrix Summary For Research Questions (Maxwell, 2013)
Study Site

This study took place at Gateway Community College in the summer of 2015. As stated on the college’s website and printed information, Gateway is a large community college located with a community college district that houses three separate two-year colleges in Southern California. Gateway is a diverse community college offering more than 250 degrees and certificates in numerous academic disciplines, vocational training, and enrichment courses. This institution serves a dual mission: to provide open access to all who can benefit from instruction and to meet the diverse and ever-changing educational, cultural, and economic needs of the urban core and surrounding communities. Gateway recognizes that the development of the whole person is essential for him/her to succeed as students, become active citizens, and to effectively contribute to a global community. As a result, Gateway is committed to ensuring and maintaining a community college that promotes learning, understanding and respect for students, faculty, staff, community, and the environment.

Developmental Mathematics Courses

During the course of the study, there were three sections of Math 46 courses, each taught by a different professor. Math 46 is a 5-unit course, which integrates elementary algebra and basic geometry. The summer courses were “accelerated” classes because they were eight-week courses that met daily, four days a week for two and a half hours per day. Each class was provided with two qualified math tutors in the classroom every day.

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1 For purposes of confidentiality pseudonyms are used for all person and place names.
for the entire length of the 8-week summer session. The purpose for having tutors was to have additional individualized help in the classroom. The help from the tutors not only provided immediate support for students, but also served as additional resources and support for the teacher to target students’ actual learning needs in real time.

Participants

The three classes had a total of 73 enrolled students (M = 24, range 23 to 26), and 37 students volunteered to participate in the study. All of the professors who taught these courses volunteered to participate in the study. All participating students completed an on-line survey. Student responses to the survey focused on student characterizations of the students’ learning styles/needs in relationship to their professor’s teaching style. The data collected from the student survey was also used to inform semi-structured interview and focus group questions. Seventeen of the 37 students surveyed volunteered to participate in the interviews (semi-structured and focus group). Thirteen of the 17 students participated in the semi-structured interviews and four of the 17 students participated in two focus group interviews. All three of the mathematics professors participated in semi-structured interviews.

In addition to the interviews and focus groups, all of the consented students completed an on-line survey via Google Forms. The survey not only helped inform the semi-structured interview and focus group questions, but it helped the researcher better understand student characterizations of the students’ learning styles in relationship to their professor’s teaching style. Seventeen of the 37 students surveyed volunteered to participate in the interviews as well.
**Qualitative Research Design**

A qualitative method approach was used to answer the research questions. Data collection and analysis took place during the summer of 2015. Data was triangulated via field note observations, surveys, semi-structured interviews, and focus group interviews. Triangulation of data “involves checking information that has been collected from different sources or methods for consistency of evidence across sources of data” (Mertens, 2010, p. 258). Triangulation helped to reduce biases and provide a better assessment of how one makes specific generalizations about the sources of data (Maxwell, 2013).

This qualitative study used three primary data sources, which consisted of two phases. In phase one, online surveys were created and conducted via Google Forms to gather data on students’ perceptions of their learning needs and styles in relationship to their professors teaching styles. In phase two, semi-structure and focus group interviews were conducted. Classroom observations were also conducted in this phase. Semi-structured and focus group interviews were conducted to gather further insights on how students believed their learning styles connected to their professors teaching styles as well as to better understand what supports and resources students believe they need to succeed in developmental math classes. Professor semi-structured interviews were also conducted, as well as observations, to gather data on how they perceived students’ learning needs in developmental mathematics. Observations were conducted to verify and add context to students’ and professors’ stated perceptions.
Phase 1 of Study

Informed Consent

All students who were enrolled in the classes and who were 18 and over were invited to participate as consented adults. Students who were under 18, at the time of the data collection, were also invited to participate and asked to sign adolescent assent forms. Their parents were provided parent/guardian consent forms in Spanish or English. The consent forms were distributed directly to students. Their assents and self-consents or parental consents were for their volunteer participation in the study and for the audio taping of the interviews. Participation in the research study was not required; students were given the option to opt out of the study and fully participate in the course. There were no costs to the students for participating in the study.

The average age of the participating students was 23. Approximately 68% of the students were female, and most came from Latino and African American backgrounds (49% and 19%, respectively). Students’ and professors’ names were held confidential. Student data received a random identifier to replace names right after they consented. All students who consented to and participated in the approximately 45-minute interviews received a $5 Starbucks gift card in exchange for their participation.

Survey Procedures

Prior to classes starting, the research team met with the professors and department chair to discuss the study, procedures, and obtain consent from the professors who volunteered to participate in the study. Once classes began, the researcher visited all three Math 46 classes of the three professors who volunteered to participate in the study to introduce the study, procedures, and consent their students. Professors and students
received a detailed explanation of the study and procedures. Following classroom introductions and consenting students, the researcher then contacted each professor via e-mail providing them the with a list of their students who volunteered to participate in the study as well as a survey link, via Google forms, to provide via e-mail to their students. The survey took approximately 15-20 minutes to complete (see Appendix A). Students received information about the survey and other data collection requests in the participant consent form (see Appendix B).

**Student survey.** The purpose of the survey was to answer the research questions as well as select student participants to participate in the interviews. The student survey included Likert-scale and open-ended response items, demographic questions including students’ high school math experience, current college experience, placement exam experience, study habits, tutoring services, self-reported learning styles in mathematics, and their professors’ teaching styles.

According to Mertens (2010), “surveys are good because they allow collection of data from a larger number of people than is generally possible when using a quasi-experimental or experimental design” […] and they “can be thought of as methods used for descriptive research or as data collection methods used within other research designs” (pp. 172-173). The purpose of the survey was to conduct a comprehensive and systematic way of understanding the learning needs of students, from their perspective, as they pertain to developmental mathematics.

**Phase 2 of Study**

The second phase of the data collection and analysis process consisted of conducting classroom observations and interviews. According to Mertens (2010),
“observation allows collection of data through the researcher’s direct contact in the setting” (p. 370). Mertens (2010) further asserts, “interviews can be structured or unstructured in-person or via electronic means, in-group or with an individual” (p. 370).

**Observation Procedures**

A minimum of two classroom observations was conducted per class, which lasted 45 minutes to an hour to complete. The research team then created and shared observation notes in Google Docs. The observation notes included lesson topics, observation date and time, total number of students in class, how students were grouped, the general pattern in which the professor and tutors interacted with the students, the general pattern in which the professor interacted with the tutors, and the general pattern in which students interacted with each other.

The purpose for observing the classroom setting was to provide information about teaching practices and professor-tutor-student interactions during the class. During the observations, the research team assessed the design, set-up, and layout of the room, execution of lesson plans, and delivery method. In addition, the research team assessed student-to-teacher interactions, student-to-tutor interactions, student-to-student interactions, depth of explanations, and the position of professor.

**Interview Procedures**

After all of the survey responses were submitted, the researcher visited all three classes to sign students up for interviews. A sign-up sheet requesting student’s name, phone number, and availability was passed around for students to complete. Following the sign-up sheet, the researcher contacted students via phone call and/or text to remind them of their interview as well as provide them with an interview location that was most
convenient for them. According to Mertens (2010), the advantages of conducting semi-structured interviews allows for the interviewer to “use a less structured approach, conduct the interview in a more conversational style, and probe more easily for understanding and additional information” (p. 178).

The semi-structured faculty interviews were conducted with the three math professors who taught the three Math 46 classes. The purpose for conducting interviews with professors was to understanding what professors believed about their students’ learning needs, reasoning behind their lesson planning, and whether or not professors were teaching to the learning needs of their students. The faculty interviews, which lasted between 45 minutes to 1 hour, documented the professors’ planning process, thinking around planning and designing the course, and their approach to the curriculum design, pedagogy, and assessment. These interviews occurred towards the end of the summer for the purposes of capturing the context of the course and the professors’ thinking and planning process as they designed and enacted the course(s).

The semi-structured student interviews were conducted with 13 of the 17 student participants. The student interviews, which also lasted between 45 minutes to 1 hour, documented their high school math experience, current college experience, placement exam experience, study habits, tutoring services, self-reported learning styles in mathematics, their professors’ perceived teaching styles, and their future goals and aspirations. All interviews were audio-recorded and transcribed (see sample protocols in Appendix C). Professors were informed that their participation is voluntary. The three professors who participated in the interviews did not receive any compensation. Professors received an adult consent for their participation in the interview portion of the study (see
Appendix D). See Table 1 above for a summary of the data sources and the research questions they seek to answer.

Mertens (2010) notes “using focus groups as a research strategy would be appropriate when the researcher is interested in how individuals form a schema or perspective of a problem” (p. 240). Furthermore, conducting focus group interviews allows for “additional insight gained from the interaction of ideas among the group participants” (Mertens, 2010, p. 370). The focus group interviews consisted of two focus groups. Prior to interviewing students, the plan was to conduct all focus group interviews. As a result of students’ availability, the number of focus groups decreased and the number of semi-structured interviews increased. Each focus group lasted approximately 45 minutes, with consented students. The focus groups consisted of two students per group and were conducted during a time that was most convenient for the student participants. Student participant questions, both semi-structured and focus group, inquired about students’ feelings about the course, prior experiences in mathematics in high school, and future plans. Participating students received a $5 gift card to a local Starbucks.

**Data Reduction and Analysis**

Data reduction and analysis will be described in two phases, which corresponds with the data collection phases. Phase one consisted of student survey data and phase two consisted of student semi-structured and focus group interviews, professor semi-structured interviews, and observation field notes. The purpose of the student survey and interview reduction analysis phase was to gain a deeper understanding of the supports and resources students believe, in their own words, they need to succeed in
developmental math classes and persist through the developmental mathematics pipeline. The purpose of the faculty interview reduction analysis phase was to better understand what professors believe, in their own words, about their students’ learning needs. Additionally, the faculty interviews helped unpack the reasoning behind their lesson plans and instructional practices they decided to use to help further students’ thinking and understanding of mathematics. The purpose of the classroom observation data reduction analysis phase was to not only observe the matches and mismatches between expressed student needs and instructional practices, but also to further verify whether or not students and professors arrived at similar conclusions about what students needed.

**Phase One**

Phase one data included student surveys. Three online surveys were downloaded from Google Docs and combined into one worksheet using Microsoft Excel. Respondents were assigned numbers based on their professor (e.g., Bailey-100, Williams-200, and Gomez-300 (all pseudonyms) and Timestamp (i.e., order in which the survey was submitted). Responses were coded and organized. The survey data analysis file was exported as a .txt file and uploaded into HyperRESEARCH for further analysis.

The open-ended student survey responses were first analyzed using Microsoft Excel to find connections among students learning styles and how they relate to their professors teaching styles. Following this analysis, the initial survey data was saved as a .txt file and uploaded into Hyper RESEARCH to further analyze connections among students’ characterizations of their learning styles and experiences in developmental mathematics. The open-ended student responses were coded in HyperRESEARCH using both a priori and emergent codes. In addition to coding, the researcher generated a
frequency report to further analyze code frequencies and open-ended student survey response data.

**Phase Two**

Phase two data included semi-structured interviews, focus group interviews, and observations. The first coding pass consisted of printing the transcripts out and analyzing on paper using different color highlighters. The first coding pass also consisted of open coding, applying a priori codes, and identifying emergent codes (Maxwell, 2013). The a priori codes and emergent codes are listed in Table 2 below. Student semi-structured interviews were transcribed, exported as .txt files, organized, and uploaded into HyperRESEARCH for further data analysis.
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A priori codes</strong></td>
<td></td>
</tr>
<tr>
<td>DM Effectiveness</td>
<td>How effective professors think DM is working for students</td>
</tr>
<tr>
<td>Instructional Practices</td>
<td>Teaching strategies that professors use to ensure students are learning</td>
</tr>
<tr>
<td>Kinesthetic Mindset</td>
<td>Hands-on, note-taking, etc.</td>
</tr>
<tr>
<td>No Match in Teaching</td>
<td>No match between professor’s teaching style and students' learning needs</td>
</tr>
<tr>
<td>Other Learning Styles</td>
<td>Combination of learning styles</td>
</tr>
<tr>
<td>Prof. Attitude DM</td>
<td>Professors’ feelings about teaching DM</td>
</tr>
<tr>
<td>Prof. Experience</td>
<td>Professors' background/professional experience</td>
</tr>
<tr>
<td>Professor Support</td>
<td>Strategies professors' are using to support students</td>
</tr>
<tr>
<td>Tutor Communication</td>
<td>How is the communication between professor and SI/tutor? Do they communicate regularly? If so, what is discussed?</td>
</tr>
<tr>
<td>Tutor Support</td>
<td>In what ways are the SI/tutors supporting students?</td>
</tr>
<tr>
<td>Teaching Style Match</td>
<td>Match between professor's teaching style and students' learning needs</td>
</tr>
<tr>
<td>Visual/Auditory Learner</td>
<td>Seeing and hearing</td>
</tr>
<tr>
<td><strong>Emergent Codes</strong></td>
<td></td>
</tr>
<tr>
<td>Approachable and Comfortable Attitudes</td>
<td>Students feel comfortable approaching professors</td>
</tr>
<tr>
<td>Checking for Understanding</td>
<td>How students perceive their ability to do math</td>
</tr>
<tr>
<td>Confidence Life Outside of School Practice</td>
<td>Students ability to do the math</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Professor's awareness of students workload outside of school (whole adult)</td>
</tr>
<tr>
<td>Preparing Students</td>
<td>Professors' believe that students need a lot of practice with the mathematics. As a result, a lot of examples are given</td>
</tr>
<tr>
<td>Future Research</td>
<td>Findings that do not address my RQ's</td>
</tr>
</tbody>
</table>
Student interviews. The first coding pass consisted of printing the transcripts from student interviews and analyzing them on paper using different color highlighters. The first coding pass also consisted of open coding, applying a priori codes, and identifying emergent codes (Maxwell, 2013). Focus group interview transcripts exported as .txt files, and uploaded into HyperRESEARCH for further data analysis. There were a total of two students per focus group. As a result, the researcher uploaded a duplicate transcript for each focus group interview to make coding and data analysis more manageable.

Professor semi-structured interviews. The first coding pass also consisted of printing transcripts and analyzing in the same way that the student interviews were analyzed. In addition, open coding, applying a priori codes, and identifying emergent codes were apart of the first coding pass (Maxwell, 2013). The second, third, and forth coding passes were all conducted via HyperRESEARCH in which additional emergent codes were added. Additional passes of analyzing the data resulted in a recursive process, which included analyzing transcripts, looking for and merging codes, developing or changing codes, and repeating the process again. The professors’ semi-structured interviews were transcribed, exported as .txt files, and uploaded into HyperRESEARCH for further data analysis. The first coding pass consisted of printing the transcripts out and analyzing on paper using different color highlighters.

Classroom observations. The research team conducted classroom observations. The notes from each observation were shared via Google Docs. Observations were then exported as .txt files and exported in HyperRESEARCH for further analysis.
**Data analysis.** Student and faculty interviews transcripts were coded using a priori and emergent codes. As the data was collected, the a priori codes were applied and coded and new codes emerged from this process. As a result, multiple passes of the data analysis were made to ensure codes were consistent among all of the data. In additions to coding with multiple of data analysis passes, codes were shared with professors and other graduate students to further test validity.

**Limitations of the Study**

There were possible limitations to the proposed study. First, this study sought to understand how community college students characterize their needs and learning experiences in an accelerated developmental math class over a short time period (one summer session). Second, this study only used a sample of students (37) and professors (3) at a single institution, which is not enough to generalize quantitatively to other populations or institutions. However, results as well as students’ and professors’ voices from this study can help test the theoretical propositions of this study – notions about the ecological environment that the students exist within and how those merge or fail to merge with instructional practices. Through this theoretical testing, we can come to understand how, if at all, these types of programs can help close achievement gaps and add to the research on how to help underprepared students successfully persist through the developmental education pipeline in higher education. Third, this study didn’t pre-measure fixed v. growth mindset in the treatment and the comparison classes. As a result, it is unknown whether the treatment students entered with a higher growth mindset potential. Finally, my positionality as a high school math teacher and former college math professor could interfere with my analysis of the data. Additionally, my positionality
might cause the participants to feel like they have to alter or omit their true feelings about how they characterize their learning needs and experiences. To help minimize such mindsets, I constantly reminded students’ and professors’ that their names will be maintained confidential and that their responses will remain confidential and will in no way, shape, or effect their grade or employment. In addition, I reminded participants that their participation in the research study was strictly voluntary, and they could opt out of the study and still fully participate in the course. While there were limitations of this study, the findings should inform community colleges, four-year institutions, districts, and state leaders, from the students’ and professors’ perspective, about the supports that students recognize are important and effective for student learning.

Most, if not all, of the research on students in developmental mathematics focus on first-time freshmen. In addition, the research findings on developmental mathematics are not told from the perspective of students or the professors who teach it. Instead, research talks about students in relation to being first-time freshmen, low-income, underprepared, unmotivated, over-represented in remedial classes, and less likely to remediate successfully (Attewell, Lavin, Domina, and Levey, 2006; Bailey, 2009; Bahr, 2010; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013; Solórzano et al., 2013). This view of students only depicts a negative representation of this group of students and their ability. Additionally, it lacks the ability to understand the lived experiences of students who place into developmental mathematics. My purpose, therefore, is not only to help shed light and dig deeper into reasons why these students are struggling, but provide implications that will help them successfully persist through the developmental mathematics pipeline.
Positionality

My positionality on this topic of remediation in college mathematics affords me uniquely informed perspective throughout the research study. As a former instructor of a community college developmental math class, I was able to get a snapshot of the challenges that persist as struggling high school students attend community college and enroll in remedial mathematics classes. While teaching the remedial math class, I observed students who were enrolled in the same class, but had varying proficiencies. In addition, and more troubling, there were students who had failed the course and were retaking it for a better grade. While I was teaching at the community college, I was also teaching high school math full-time. I noticed that I was teaching or had taught the same content in my high school courses as I was teaching in the college remedial math class. I discovered that any college course, ranging from basic arithmetic to intermediate algebra, is defined as a developmental math course in the community college and university systems (Bahr, 2008; Hagedorn et al., 1999). As a result, I started to wonder: Does this imply that being successful in Algebra is the road to success in the developmental math sequence? If so, how can students who successfully pass Algebra, Geometry, and Intermediate Algebra (Algebra 2) in high school place back into those courses in college? Furthermore, how can success in these courses in one institution be considered college-ready, yet remedial in another?

Students who receive an A, B, C, D, or pass/no pass for a college course is considered to have successfully passed that course (Bahr, 2010). The graduation requirement at the high school level is successfully passing Algebra, Geometry, and Intermediate Algebra. This implies that a student is considered eligible for a 4-year
college if they pass these courses; however, these courses fall under the remedial umbrella in college. Students are praised for being in those courses in high school, yet considered “at-risk” if they place into them in college.

As a math educator, I have observed low-income and minority students struggling academically, particularly in mathematics. As a result, I want to gain a deeper understanding of how pedagogy influences student-learning outcomes. One way to successfully do that is to listen to the voices of students and faculty. The voices of students who are unsuccessful in developmental mathematics and faculty who are teaching developmental mathematics are needed to help build teaching and learning strategies that will maximize students learning needs, skills, and success. Otherwise, the curriculum, instructional strategies, and policies will continue to underserve the underprepared. If the goal of developmental education is to provide students with the necessary skills for obtaining access, and successfully completing college-level courses and academic programs, then decisions must be made to not only include student and faculty voices, but also the learning needs of students. Trying to change the cultural stigma of developmental mathematics without seeking to understand the lived experiences and learning needs of that culture results in a cycle of missed opportunities to actually make a difference.

**Chapter Summary**

This chapter presented the goals of this study, study site and participants, and described data collection and analysis procedures. In addition, research questions and limitations were also presented. To better understand students and professors’ characterizations of accelerated developmental mathematics and its role in helping
students persist through the developmental mathematics pipeline, an online survey, field
note observations, focus group interviews, and semi-structured interviews were
conducted. Findings are presented in the next chapter.
Chapter IV: Student and Faculty Perceptions of Students’ Learning Needs

Introduction

The overarching goal of this study was to explore and understand the learning needs as expressed by students, the views of student learning needs by faculty, and the ways that instructional practices may match/mismatch those needs. This study also sought to understand professors’ beliefs about their students’ learning needs, the reasoning behind their lesson planning, and the instructional practices and resources they are using to ensure that the learning needs of their students are being met. For the purpose of this study, learning styles and learning needs are used interchangeably. This chapter provides a descriptive overview and analysis of the ways professors and students characterize their needs and learning experiences in an accelerated developmental math class.

There were four main themes across both professors’ and students’ responses: Practice, Mindsets, Personal Lives, and In-class tutor support. Each of the three professor participants talked about students in developmental mathematics courses as having different needs compared to students who enroll into college-level mathematics. Professors in this study talked extensively about students’ ability to learn, understand, and “do” the mathematics. Furthermore, professors talked about students’ past experiences with mathematics, which according to these professors, causes students to enter college with a lack of confidence about their mathematics ability. This lack of confidence hinges on students’ mindset and determines how they proceed as they strive
to persist not only through the developmental mathematics pipeline, but also through college in general. A person with a fixed-mindset is one who believes that they are incapable of learning because of past unsuccessful experiences. As a result, they run from challenges; which hinders their ability to persist through any task (Dweck, 2009). A growth mindset, on the other hand causes a person to use their unsuccessful experiences and challenges as motivation to overcome and persist through tasks they face (Dweck, 2009). Professors strongly believed that these students need a change of mindset in order to be successful in mathematics. Students talked about their mindset on their mathematics ability and how it stemmed from their K-12 experience. Students connected their current mathematics ability to their past ability in mathematics, which caused them to think about their success in the college-level mathematics courses they will be required to take in the future.

Second, in addition to a mindset change, professors also discussed students’ need for a lot of in-class practice solving math problems, more procedural than conceptual. Since many students enter college with a lack of confidence, professors helped students understand the mathematics by linking lectures, practice, collaboration, and in-class tutor supports to enhance student learning. Using and connecting these in-class supports was important for professors and beneficial for building confidence in their students. Professors’ responses centered on math being experiential with a strong need for students to have many opportunities to work individually as well as to work collaboratively with their classmates. Likewise, students talked about having step-by-step lecture notes as well as many examples being vital to their understanding and success in their math class. Students characterized their learning needs in the following categories: needing to see
multiple steps and examples, hear professors lecture, and a lot of practice with the mathematics they were learning. Additionally, students talked about the opportunities they were given to work collaboratively in groups with their classmates and how collaborating with tutors helped solidify their understanding of the mathematics.

Third, professors in this study believe that the outside lives of students must be taken into consideration in conjunction with planning, content delivery, and implementation of lessons. For this reason, they utilized the class time to effectively maximize students’ thinking and understanding of the mathematics. Students in this study talked about their past experiences with math as being “difficult.” As a result, many of them felt like they placed in the right course because they felt like they needed to refresh themselves in the mathematics.

Finally, the professors maximized class time to help support students by providing in-class tutors. Professors talked about in-class supports, such as in-class tutors and more time to understanding the material in-class, are needed to help students persist through the developmental mathematics pipeline. The help from the tutors not only provided immediate support for students, but also served as additional resources and support for the professor to target students’ actual learning needs in real time. Students also talked about how they valued the in-class tutor support. Many students preferred going to their tutor first for support. The findings from both professors and students will be explained in greater detail below.

**Skill Development and Collaboration**

For the purpose of this study, practice primarily focused on procedural skill fluency, both individual and collaborative practice, which builds from of experiential
learning. Professors and students both talked about the importance of practice. Professors centered their responses on math being experiential with a strong need for students to have many opportunities to work individually as well as to work collaboratively with their classmates. Students centered their responses on needing more time to practice the mathematics (individually and collectively) for the purposes of understanding and succeeding in their math class. Professors and students both articulated a shared belief that students need substantial time for in-class procedural skill practice and collaboration to be successful in developmental mathematics. Most of the developmental mathematics curriculum as well as the instruction observed in this study focused on procedural skill practice. This is expected given the pre-Common Core traditional stand-and-deliver model of teaching and learning. This is different from conceptual practice or understanding, which has caused a major shift in K-12 teaching and learning as a result of the recent implementation of the K-12 Common Core State Standards balanced approach to mathematics.

**Professors’ views on practice.** In this study, all of the professors talked about students needing significantly more in-class practice to be successful in developmental mathematics than students in higher-level math classes. All of the professors noted various ways they structured their lectures to incorporate practice time for students. Professor Williams remarks:

And then practice. I try to do a ton of examples, and then like my examples I have them do on their own, which are basically the same thing, just different numbers that they can follow. I try and write the steps out, just to make it as logical. And doing different things. So I like to do group activities so that they kind of have to work together.
For Professor Williams, giving students lots of examples that are easy to follow from the lecture notes was extremely important for students. The examples given look similar to the examples given in the lecture notes, with the exception of different numbers. Professor Williams argued that creating multiple examples not only gave students extra practice, but also helped them to ensure whether or not they have mastered the skill(s) necessary for solving the problems correctly.

Similarly, Professor Bailey responded:

The important things is when I am going over something give them an example and let them work on it on their own, not even on their own they can work with each other but during lecture there needs to be breaks of you so you’re not just talking the entire time and they need to be able to try something on their own.

For Professor Bailey, allowing students to practice the mathematics on their own or with classmates is vital to their success in developmental mathematics. The key to students working on their own does not imply that they are sent home with more homework problems than average. Rather, students are given in-class time to practice the multiple examples given by professors. The amount of practice problems depends on the level of the math class. Professor Bailey further noted:

Some classes, depending on the topics being covered, I may do more or fewer examples. Like in the developmental level, I really like to give lots of examples and have them do lots of examples. Whereas in a higher-level course, I will still give them one to do, but [then] they move on. The pace may be a little bit faster.

Professor Gomez focused on the importance of classroom interaction as an important part of practicing the math content. Professor Gomez explained, “I would rather have them start learning what they need to learn in the classroom, interact with each other, work
with each other, ask your questions now.” It is vital that professors are utilizing class
time to effectively meet the needs of their students.

It is evident that Professors Williams, Bailey, and Gomez all perceived students in
developmental mathematics classes as needing in-class time to practice what they are
taught. As a result, they adapted by allowing in-class time for students to collaborate with
their classmates, tutors, and ask additional questions. Furthermore, they were available
during office hours and made sure students visited out-of-class tutoring sessions with
some of the in-class tutors. They also used a variety of strategies for delivering the
content: white board, document camera, and posting lecture notes online.

Professors in this study were aware that some students might be shy or have
difficulty adapting to the college class environment. Additionally, they understood the
reality of students needing to interact not only with the mathematics being taught, but
also with other supports such as the professors themselves, tutors, and other students
enrolled in the class. As a result, professors created classroom environments that were
conducive to students learning mathematics in ways that matched their learning needs.
For example, the professors in this study utilized class time to allow students to work in
groups to discuss the mathematics being taught. Also, the professors along with the tutors
circulated the classroom to check for understanding, answer questions, and clarify any
misunderstandings. Furthermore, the professors focused more time and attention on
students coming to class, taking notes, and finding out whether or not students
understood the mathematics being taught prior to leaving class; rather than students
trying to figure out how to do the math by themselves once they went home. This
included students working individually and collaboratively with their classmates, tutors, 
and professors. Professor Williams explained:

I feel like, when I was a student at least, one thing that was beneficial for 
me, which I didn’t necessarily love at the time but it helped, is I had to 
reiterate the steps to other students. And it really helped ingraining the 
process with me… obviously I do examples in lecture and stuff, but I try 
and do more on their own so that they just get more practice instead of 
saying oh yeah, I know how to do it.

For the professors in this study, practice consisted of more than just doing homework 
problems. Instead, practice consisted of students working individually, with tutors, with 
professors, and with their peers. As a result of professors valuing in-class practice for 
their students, their instructional practices incorporated the in-class time necessary for 
them to do so. Professor Bailey stated:

Oh I always try and give them time for every single thing I do. I try to set 
it up so that I will do one or two examples, we’ll work them together as a 
class and then give them one or two examples to work out on their own 
and we’ll just check and see if everybody got the answer. And I will go 
over the steps on how to do it, but give them the opportunity to try it on 
their own.

The observations conducted in this study confirmed the views expressed by the 
professors. On each of the eight classroom observations students were given the chance 
to practice a lot of examples following the lectures. They were also able to collaborate in 
groups. The extra example problems provided and opportunity for students to determine 
whether or not they understood the material being taught because the example problems 
were similar to the problems and scenarios given in the actual lectures with the exception 
of the numbers being changed. Additionally, professors did not lecture during the entire 
class time for the purpose of allowing students to collaborate in groups, work with tutors, 
and ask questions while in class.
Students’ views on practice. The professor responses were closely aligned to the student responses. Some students simply answered that they were visual learners, while many students commented that they needed to see examples and hear step-by-step explanations. For example, one male student wrote, “Visual. Like I have to see it so I could learn better.” Another female student wrote, “I’m a visual learner, so I have to see something done and showed before I can start and do it myself.” Some students had a combination of learning styles. As one male student explained, “I learn best when I see something I do by myself, not only listening, when I practice.” For this student, he had to not only see and hear, but also practice what he saw and heard. According to Professor Gomez, learning mathematics is equivalent to learning a new language. This implies that students have to not only hear, but also see and practice the problems they are being taught.

Students responded that they needed to repeat steps multiple times or needed to use a “hands-on” approach. For students, using a “hands-on” approach implies that they need time to practice the content in which they are learning, even if that means practicing the problems more than once. One male student wrote:

Hands-on, using different examples, going over problems individually and even if you have to go over it three or four times or two or three different ways it helps to reinforce everything. And also knowing that you are not going to be penalized for it, or it’s not on the test or anything, you know… I learn well through examples and analogies and things of that nature, like I said earlier he (Professor Gomez) uses real-life scenarios and situations to make the connection.

For this student, practice allowed for him to get better without penalty. This served as motivation to keep trying even when a mistake was made. In general, students who have struggled in mathematics fear that they will fail before they even try to succeed. This
mindset may hinder them from trying altogether. Being in a class designed to give
students lots of practice will help minimize students’ fear of failure. It also helps students
determine their actual learning needs. A female student explained:

I have to actually write things out and I have to actually do them. I can’t just watch a video of something and get it. Like I have to actually write
down. Like I’m a really big note taker because that’s how it retains in my head.

This student’s effective learning need was connected to physically writing things down
and practicing what she wrote down. If this student had a professor who lectured more
than writing notes down, then this student would most likely struggle. This does not imply that she would struggle as a result of the mathematics being too difficult for her, but rather because she needs to take copious notes. It is vital that professors are aware of
students’ learning needs rather than teaching using a one-size-fits-all approach. Other respondents made similar statements to the ones above. Some commented that they needed to see and hear multiple examples then repeat it multiple times on their own.

Although there was intersubjectivity between students’ and professors’
characterization of students’ learning needs, there were three respondents, one female and
two males, whose learning needs were connected to the pace of the class and workload.
For example, the male student wrote:

For me, when it comes to math, and that’s what I struggle in most, I feel that the pace of the class shouldn’t be extremely slow, but it should be just so that we’re able to cover one or two topics or subjects in a day, that we understand it and are able to practice it the following day or following class to where we understand it in preparation for exams, quizzes, tests and whatnot.

For this student, pace of the class was extremely important. This student wanted to ensure that he understood everything that was being taught, and that is difficult to do if the pace
of the class is too fast. This student also mentioned he needed to be able to practice the material the following day *in-class*. Additionally he needed to understand it well enough to do well on future assessments. The other two students whose learning needs were connected to the pace of the class had similar responses as the one above.

All students stated that their professors’ teaching style matched their learning needs within the categories of needing to see, hear, or use a hands-on approach to help them understand the mathematics being taught. In addition, there were multiple students who stated that their professor matched a combination of at least two of the categories listed above. A female student wrote:

I think it matches perfectly because I mean that’s what we do. We do a whole lot of problems. As he’s showing us examples, he’s telling us okay, you do it, and then we’ll see what answers we came up with, and if you guys did the right procedure.

This same student stated that there was no difference between her professor’s teaching style and her learning style: “I don’t really think it does differ because there’s so much of hands-on. It’s ‘write this problem out.’ And he’s real specific about the homework.” Another female student with a combination of learning styles category wrote, “So like they have to kind of talk through it and like write it down on the board. And then I have to do it too.” This student learning needs were connected to her hearing the professor talk through the mathematics, seeing notes and examples written down, and then trying it out on her own.

Although her professor matched her learning style, there was a slight mismatch between his teaching style and her learning style. She stated, “Sometimes he like just expects us to know what kind of questions we have. And like sometimes we don’t have
enough time to review all of them. So that’s one.” This student needed more time to understand the material and have it dissected in order for her to learn it effectively. There were other students who reported slight differences such as: long lectures, no book, fast paced. Another male student confirmed this mismatch. He stated:

Sometimes he might not go all the way into detail when it comes to certain things because he just assumes that we should know this from the other class that we took and he gives us the benefit of the doubt on that I guess. But if you ever pull him to the side or specifically ask that question he’ll stop everything and then get right back to it. But not everybody is necessarily the type of person to say ‘Hold on, I didn’t get it,’ they might be quiet. So that might be a problem at times when you might skip certain steps, you might leave somebody behind. But ultimately it is up to them to come forward.

Although this student identified a mismatch, he justified reasons for such mismatch. The only reason the professor did not go into as much detail for a particular topic was because the mathematics required students’ prior knowledge. This implies that students should have entered the class with some prior knowledge from their previous math courses. As a math professor it is difficult to assess and know all of students prior knowledge or lack thereof. During the classroom observations professors’ immediately stopped everything to address students’ questions and/or misconceptions before continuing with their lessons. The professors’ created a classroom environment that helped reduce fear and motivate students to ask for help when they did not understand.

Although this student mentioned a mismatch between his learning needs and his professor’s teaching style, he further explained that his professor’s teaching style predominately matched his learning style by stating, “I learn well through examples and analogies and things of that nature, like I said earlier he uses real life scenarios and situations to make the connection.” Many (12) students reported that there was no
difference in their professor teaching style in relationship to their learning style. Many responded that the liked how their professors wrote steps on the board or document camera, gave a lot of practice and examples, and explained each example in step-by-step detail.

Mathematical Mindset

Professors in the study believed that it was part of their job to help change students’ mindsets from fixed to growth (Dweck, 2009). Only professors talked specifically about mindsets. Students did not use the term “mindset” or indicate whether or not they have developed a fixed or growth mindset, but they spoke of their self-perceptions in regards to their mathematics abilities and their motivation attributes as a result of their past challenges and personal lives. Professors articulated a belief that, in order for students to be successful in developmental mathematics, students need to develop a growth mindset. When students talked about their past experiences learning mathematics, their statements confirmed the perceptions of the professors.

Professors’ views on mindsets. The professors in this study believed that part of their goal was to help change students’ mindsets about their ability to not only learn math, but also their ability to understand and do the mathematics. As a result of changing students’ mindsets about developmental mathematics, professors believed that they could help students build enough confidence to change their attitude toward mathematics as they strive to succeed. Professor Williams stated:

I think the biggest thing is practice and confidence. So the very first day, like some students come in just thinking math is hard, or I’m not good, I’ve never been good. Already with that mindset that I’m going to fail and so I think that’s the hardest part to get past is just their attitude. So any way that you can give them confidence, which is huge. Even for some of
those students that finally, like at the end of the semester, not even raise their hand in class, but as I’m walking around will like hey, can you check this? That’s like a huge step for them wanting me to see their work.

Professor Williams believes that prior to teaching students mathematics, it is vital that to help change their mindsets. Many students who place into developmental mathematics have always struggled or had difficulty-learning mathematics. As a result, they enter college with a struggler mindset. This mindset blinds students from seeing that they are capable of not only learning the mathematics they struggled with in the past, but the mathematics necessary for them to obtain a college degree. If students’ perceptions about their ability to learn mathematics are not changed, then they will continue to struggle, stop-out, or completely drop out of college. In addition to changing students’ perceptions about mathematics and their ability to do the mathematics, professors perceive that responsibility to also be linked to word choice. Words of encouragement play a key role in changing students’ mindsets about their mathematics ability. Professor Gomez explained:

I have learned to play on words, like I tell my students ‘None of you are stupid, but sometimes we make stupid decisions, right? So let’s figure out what decision we have today so we are not looked upon as stupid. Because I know some of you were called stupid once in your life because you didn’t know how to do math.’ And sometimes we have to work around that, that is what I call the damage that has been done, words that have been used, actions that have been forcing someone to go to the board when they are fearful of being in front of everybody. That destroys them.

For these professors, helping students change their mindset about their ability to succeed in mathematics helps students go from a fixed mindset to a growth mindset. This mindset is a result of students’ past experiences with learning mathematics and comments that were made to them about their mathematics ability. As a result, professors in this study
believed that word choice is critical because it can cause a positive or negative impact on students and how they feel about themselves. Students’ mindsets are predicated on how they are spoken to or praised (Dweck, 2009). This impact, positive or negative, can have a lifetime effect on them.

Based on the professors’ voices, it is evident that they perceived students’ mindsets and attitude towards their ability to learn and understand the mathematics as critical components for successfully persisting through the developmental mathematics pipeline and college. Professor Williams noted, “I played sports in college and it’s like 90% mental. So I think your attitude…and whether or not you like your career. So much of it is your mindset, that attitude.” In addition to mindsets affecting students’ performance, their attitude is also a key component to their success because it also affects how they view their ability to overcome past doubts and learn the mathematics.

In addition to confidence and mindsets, professors believed that student’s mindsets (fixed vs. growth) about their ability to understand mathematics stems from their experiences prior to entering college. Professor Williams further explained:

I think a lot of it comes like from before as well. Like students are missing something when they go through school. So by the time they get here. And I’m still trying to figure out how to change their attitude from Day One when they walk in the door. Because if they come in thinking hey, I’m going to be successful, I’m going to try, I’m going to read my book, I know I can do this, I’m going to put the effort in, that would change students’ success dramatically I think. And then offering them as much as possible. So I’m still working on how to help them have confidence.

Hence, the way students were taught mathematics in K-12 has hindered their confidence in their ability to learn and understand the mathematics well enough to be successful. As a result, helping students to understand that they not only have the ability to learn things
they may not have learned in the past, but also learn new mathematics as well can be a challenging undertaking.

For the professors in this study, teaching the mathematics was just a piece of what they believed was required for them to help students not only pass their class, but prepare them for future classes. Professor Bailey explained,

I know not all of my students will be going on in math, but I like to prepare them in case they do. There is no reason just because they are in 46/96 now that they can’t go on to be a math major. And so I don’t want them to be poorly prepared, to go on to a calculus class and have no idea what the professor is writing. I want them to at least be exposed to it and get used to it. I want to prepare them for whatever comes, essentially.

As a result of students entering college underprepared, professors not only have the task of plugging the leaks in students’ mathematical knowledge, but also ensuring that they are prepared to engage in higher level mathematics. This can be an unnerving task especially since many students’ are disadvantaged from the moment they enter elementary school. Nonetheless, professors in this study are working to ensure they prepare students to the best of their ability to prepare them for “whatever comes”.

Professor Gomez stated:

Here at Gateway College (pseudonym), maybe it’s a California thing; we have our elementary school teachers take two math courses. Right, the sequence AB where they do math for elementary school teachers, but that’s it! They really don’t have to take any more than that, no transfer level coursework, none of this stuff, just those two classes and then they can be teachers. Do they understand what math is all about? Probably not, right? And so we get the kids, unfortunately who then have the coach in high school, the football coach was the math teacher, the baseball coach was the math teacher instead of the other way around, the math teacher was the football coach, that would be awesome. But it’s always the other way around. They have people teaching people math and they don’t understand it.
Professor Williams and Gomez believed that the success of students was linked to the knowledge or lack thereof of their previous teachers. Professor Gomez talked about how vital learning and understanding mathematics in the early grades is for students. He explained that math builds from year to year and students rely on their prior math knowledge to help them learn new material. This caused him to question what teachers are doing in the lower grades and whether or not they themselves are prepared to teach the mathematics they are expected to teach. He further questioned how teachers could prepare the underprepared if they themselves are not prepared. As a result of students being underprepared, professors in this study shared beliefs that strongly influenced how they viewed the needs of their college students. Professor Gomez suggested:

I don’t know what we are doing in the bottom but of course we have to change it. But really it is a structural problem, it’s really just we need more people like yourself, more people with the evidence to say ‘You know what, we need to put people in who understand math at every level.’ If you have to separate the math from everything else, fine. Then you put people who know what they are doing with the math regardless of the level and then you send the students to them. And we have to get away from this idea that one teacher can do everything because it’s not true. Not at the elementary school level. It’s got to be somebody who is very powerfully gifted with all aspects of the educational system at that level, somebody who has a lot of experience doing that.

Professor Gomez has strong beliefs about changing the instruction that goes on in elementary school. As a result, he offered a suggestion of separating the mathematics from other content areas. In the interview, he stated that students’ teaching and learning of mathematics would be more effective if teachers who have a greater mathematical content knowledge were situated in elementary schools. He went on to say that, by the time students enter high school they have many misconceptions, doubts, gaps in their knowledge, and are underprepared for college-level mathematics. As a result, they place
into developmental mathematics classes upon entering college, although they may have passed a similar course in high school. According to Professor Gomez, we need to start with the lower grades and work our way up to the high schools because students who have difficulties in elementary school also have difficulty learning and understanding mathematics in high school, although their transcripts may suggest otherwise. Professor Gomez stated:

So that comes out in the performance of these students, they come to us and we assess them and they’re like ‘Well they supposedly had trigonometry in high school.’ But yet they are assessing at Math 38, they are in our entry level, not even Algebra, Pre-Algebra. And so apparently something is not kosher, it’s not coming together very well. Because we have sometimes even somebody who supposedly was very high in their GPA in high school but they are coming here to us, and their English is low and their math is low and we’re like, that’s not supposed to be happening. They are supposed to be ready to get into transfer level courses.

When students enter college, they are expected to have understood the content well enough to pass. Professors have learned that is not the case because students are passing their classes in high school, which deems them college ready, yet placing back into those courses in college. As a result, the college has to remediate students so they are prepared to engage in college-level courses. Remediation, although it consists of topics they should have learned previously, can be a difficult task as Professor Gomez further explained:

I am trying to teach math to people who don’t know the alphabet. They don’t know what they are looking at. They don’t know A from Z. And you want me to teach them algebra but yet they don’t know the fundamental language of math. They’re already at a disadvantage because they don’t have all that stability that they would have had to learn math. So they have, I call them gaps; they have these gigantic holes that they come with to me to my classroom. And my job is I am always spackling. I am always covering another hole. Oh I see you have a hole here, let’s cover that hole. They come to me like a really holey Swiss cheese, that’s what I think about. It’s big blocks of Swiss cheese in front of me, every single student
and it’s Swiss cheese that has gigantic holes in it. And then we think that because we are doing this 16 weeks or eight weeks that oh yeah they are going to get it because they’ve seen this stuff so many times. If you don’t do something different, you’re still going to be at 40%-50% success rate.

Based on the professors’ perceptions of students learning needs, it is evident that students enter college underprepared, not just for transfer-level mathematics, but also for developmental mathematics. For these professors, changing students’ mindsets stems from changing their attitude, which helps students’ build confidence in themselves and their ability to successfully persist through the developmental mathematics pipeline. Although they enter into college underprepared to engage in college-level mathematics, these professors are doing “something different”-- they are doing what it takes to help students not only succeed in their class, but get them ready for future classes. Professors also articulated a belief that students’ struggles are not associated with them being “horrible at math”; instead students’ just have small gaps or gigantic holes that need to be filled. For the professors, it is important to they get to know their student in order to understand which holes need to be filled. If educators can help students conceptualize their struggles in math as related to a set of holes in their knowledge, which simply need to be filled that would be quite different from the students original thought that they were simply “bad at math.” Once students begin to conceptualize their struggles as holes that can be filled, they gain a new perspective of their ability to succeed. Thus, the students can begin to develop a growth mindset.

**Students’ views on mindsets.** Students in this study reflected on and talked about their past experiences in high school in relationship to their mathematical abilities. Consistent with the professors’ perceptions, most students reported having difficulty in
their prior math experience. One student expressed, “I was never very good at math. It was the one subject I actually struggled with a lot. I had to repeat the Algebra course. I took it once and failed, and then I had to repeat it in order to graduate.” Another student wrote, “I struggled with it and I'm still struggling with it I'm not sure how I even passed with a B. I don't think I learned the tools in high school for math.” Students’ past experiences, “awful”, “bad” or “horrible”, in high school were connected to how well they performed in mathematics. Many students connected their level of difficulty with their experiences. If math was difficult for them, then their experiences were classified as “not good”; and vice versa. Students who struggled wished they had attending tutoring. One male student reported, “It wasn’t a very good experience because it was difficult. And probably like a little tutoring would have helped me a lot.” Although many students found math to be very difficult, some of them connected their good experiences and passing grades to the amount of support they were receiving. Another student wrote, “I find math very hard, and I often struggle with math, almost to the point where I barely pass math, for instance Algebra 2 in my junior year, in the first semester. The only time I did well in math was geometry in 9th grade, because I had a lot of help, and it was the math class passed with a highest grade with a B+.” A third student talked about his frustrations with not completing his math courses in high school, yet he graduated anyhow. He explained:

I entered high school, my first high school, in 9th grade and I took Algebra … Pre-Algebra. I did okay; I think I passed with a C. Then I took Geometry, which I passed half the semester. The next year at 11th grade they just moved me up to Algebra II without even passing Geometry, only just part of it. So I never got to complete Geometry.
This student further explained that he transferred schools and still received an “alternative diploma” without completing his mathematics requirements. As a result, placing into developmental mathematics was where he felt he belonged. Although, he received his diploma, he further explained, “I wanted to take those math courses and complete them.” Completing his math requirements in high school could have better prepared him for the placement exam in college. Although many students reported having bad experiences in high school, there were a few who reported having “good” experiences. A male student wrote:

My high school experience, particularly in math was good. I got the chance to solve different types of equations and word problems that are helpful in real life especially in a career involving mathematics. Also, it gave me the true knowledge of math and improved my solving skills.

A female student answered, “I struggled but always got good grades because I went to tutoring”. A male student wrote, “My high school experience in math was pretty good. I had my ups and down but I managed to always get a good grade through hard work!”

Students in this study shared past experiences in mathematics, which were connected to how well they performed in mathematics. There were students in this study who mentioned that they struggled with math, but experienced success as a result of hard work and/or support. However, most students expressed themselves as students who struggled, as a result having difficulty in mathematics. Students also talked about themselves as being “ slackers”, “not trying hard”, and “giving up” because of how difficult mathematics was for them. Students’ responses confirm the professors’ perceptions about their mathematics ability prior to entering college. Student comments suggested a fixed mindset. They believed that they had always had difficulty with math,
and this pattern was not likely to change. This was the same mindset that professors in
this study sought to change. Unless their fixed mindsets were changed prior to entering
college, students may have entered college with the same mindsets they had in their K-12
experience. While students’ comments did not discuss developing a growth mindset per-
sel, their stories about their personal lives indicated that they believed in their own growth
and potential more generally. This is discussed in more detail in the next section.

**Role of the Students’ Personal Lives**

In addition to focusing on students’ math knowledge, professors also
acknowledged that students’ often had complex personal lives outside of the classroom.
In fact, professors in this study had a keen awareness of students’ lives outside of their
classroom and school in general. They understood that students were also parents,
working full-time, and trying to put themselves through school. As a result, professors
did their best to ensure students were supported effectively. Professors articulated that in
order to help students to be successful in developmental mathematics, they needed to
consider the obstacles stemming from the personal lives of their students. Students, on
the other hand, only considered the supports stemming from their personal lives and the
intrinsic motivation resulting from overcoming past obstacles. In other words, while
professors saw students’ personal lives as challenges to their success, the students
themselves saw their personal lives as motivation to succeed.

**Professors’ perspectives on students’ personal lives.** The professors expressed
genuine understandings of students and their busy lives. For this reason, professors
expressed interest in ensuring that students were aware of the different resources
available to them on campus, that they were making good use of the resources, and that
students knew that they were valuable. Professor Williams mentioned, “I think even just silly things like knowing their name. Like it may seem insignificant but if students don’t think they matter, I think that has a bigger effect on whether or not they can continue.” It is imperative for students to know that they matter. Once students see that professors care more about them, rather than just filling empty seats, then they are more prone to work harder to succeed. Showing students that they matter consisted of, but were not limited to, professors knowing students’ names, making sure that they were aware of resources available to them, and being available via e-mail or during office hours. Professor Williams explained:

I know a lot of students, I mean this is really hard for them. They have to work full time and have families and are trying to put themselves through school. So I think just the little things matter. And of course all the different resources that we can offer them to be successful. Like getting an Ed Plan so they can have a path. Or even just like careers. Some of them are worried about why they’re going to school, what’s out there, what can they do, have a goal. Just so that when they walk through the door they matter and what they’re doing is important.

Many students enter college undecided about what they want to study. For this reason, general education courses are available to them. Additionally, students enter college without the knowledge necessary for navigating the college world. For this reason, the professors in this study believe that part of their job is to help students persist, not only through the developmental mathematics pipeline, but throughout college as well. This gives students a chance to explore and try different career paths via taking general education courses. By the time students complete their general education courses, they should have a clear idea about what they want to study. Unfortunately, not every student will have declared a major by the time they complete their general education
requirements. Many students cannot get the necessary guidance from home so it is vital that they are aware of resources available to them. Professors in this study believed that their role consisted of guiding students both inside and outside the classroom. Professor Gomez stated:

So whenever they, like the young lady that was here this morning, she was asking information on financial aid because she got on financial aid probation. So I told her these are the things you can do, you don’t have to wait until your probation is over. There is a mechanism of how you can ask for it early, and so I told her since you are in the summer classes and you’re getting two A’s, that will probably take you out of probation in the Fall, so why wait until you get your grades and then? Let’s start the paperwork now, and as soon as we give you your grades, boom, you submit that. You can be by the start of the semester already on the ball back on the good graces of financial aid.

If it were not for Professor Gomez checking up on this student about her progress outside of his class, then she probably would have waited to begin her academic probation requirements. Many students are first-time generation students, which implies they may not have the available guidance from home to help them navigate college. They enter college perhaps not knowing the right questions or ask or the resources to seek out. As a result of caring about students as a whole, professors in this study went the extra mile to ensure they were helping and supporting their students. Professor Gomez explained:

So I tell them to be very proactive, I teach them life skills, I teach them about time management. I try to instill in them why you are here, you’re here to better yourself, you’re here to get a better job, you’re here to this, you’re here to that, you’re here to rehab- whatever you’re here for, this is the place you need to be. But also, nobody gives us anything. So I tell them college is a privilege in which we give you something if you give us your time and you give us your energy, we’re going to give you something back, we’re going to change the way you do things. And that’s the goal, you’re going to change what you do for the better, to better yourself.
Community colleges are open enrollment or open admission; which implies that admission is unselective and non-competitive. As a result, students enter from various ages, backgrounds, and educational skills and experiences. Therefore, professors found that it was important to understand students’ past experiences and future goals so they could be better prepare them for where they aspired to go. Equally important was doing what it took to meet students where they were in terms of academic readiness and, from there, helping them make use of resources available to them and successfully navigate through the developmental mathematics pipeline. Professors readjusted their thinking of how mathematics is typically taught and learned so they could use the backgrounds, skills, and experiences that students entered with as tools for deepening their thinking, learning, and understanding of the mathematics. Professor Gomez further explained:

Basically, don’t teach the way you were taught (laugh) because it doesn’t work with our students. Also be well aware of the different things they bring to the classroom from their life. You know there’s mothers, there’s fathers, there’s convicts, they’re on probation, they’re homeless, they are couch surfing, they are hungry- I mean it’s the whole thing. They are immigrants, they are first generation, second generation, they’re poor, rich, middle class- I mean they’re everything. It’s the whole gamut of the world I think, and it’s amazing. And you have to do more than what was done to you. You have to look for ways to make it [the mathematics] real to them.

It is evident that students come from various backgrounds and need various supports and guidance both inside and outside the classroom. For professors in this study, it was unreasonable to try to “make it real” to students and understand what students needed to be successful without creating professor-student relationships to get to know students, their learning needs, the various resources they needed, and the various backgrounds and experiences they entered into the classroom with. Without attempting to address the
above, professors might have continued to “teach the way they were taught.”

 Furthermore, they might have missed the opportunity of giving students more than they themselves had received as students.

 **Students’ perspectives on their personal lives.** Students did not talk about their personal lives in the same way that the professors did. Instead, they talked about challenges they overcame and the people in their lives who motivated them to go to college. One male student reported:

> When I was around about 21 I was in a cold place, in court [grand] maximum security prison, always on lockdown, when we weren’t on like down we got to come out of our cells for like 90 minutes day and that was it and everyone around me was a lifer.

This student could have looked at his situation as permanent, but instead he used it as motivation to serve his time, get out, and make a difference in his life. Upon entering prison he had a fixed mindset, but he definitely had a growth mindset upon exiting prison. He used the very dark and cold place he was in to help him realize that life in prison was not how he wanted to spend the rest of his life. This student also talked about how smart the people were in prison, but they just made a bad choice that caused them to spend the rest of their lives there. However, this student had another chance at making the best of his life. He explained:

> I had a date, I had a lot of time, but I still had a date to come home and I just realized do I really want to live the rest of my life like this or have to take a chance to come back here or anything like this, nobody is doing anything, and there’s always a few people in there that are real, real smart, but they are all lifers that will never have another chance at life. So you are just seeing them and you are like, dang there are a couple people in here smart enough to run the whole country, I mean there really is, but they don’t have anything to get back to.
In addition to the “lifers” motivating him, this student also talked about how his family’s upbringing, struggles, and his environment made him want to change. He no longer wanted to be a product of his environment so something had to give and that something was his old lifestyle. He further mentioned that although he had a different journey, he still managed to get back on track and pursue his dreams. He furthered explained,

And just looking at my family history growing up, my community, and all that type of stuff it’s finally gaining perspective, that just triggers something in you and makes you want to change. And then I got an older sibling, my sister, she graduated from Berkeley. She came from out here too, same struggles, what is it- valedictorian- when you got a 4.0 or something? She got that [in high school] and she got a scholarship to UC Berkeley, full right just on the academic tip. She finished that up, and now she’s just bought a house in Oakland. So she is the only one in my family that actually is there, and I’m right behind her a little bit even though I had a different path. It’s about gaining perspective on everything, really seeing how the world works, the system works and everyone doesn’t necessarily catch on coming from the experience that I come from. So I am just glad that I at least got that vision and I am able toss it up there and compute that. And that’s the start.

This student’s past challenges and experiences motivated him not only to attend college, but also to pursue graduation and provide a better his life for himself. As a result, this student believed his growth as a whole individual could change. Unfortunately, everyone does not get the opportunity to catch up or bounce back from their past experiences and the negative environment from which they were raised. He could have allowed his past to hinder his mindset and outlook on life as never changing, but instead he decided to use his past experiences to make him a better person and college student. Additionally, his sister served as motivation to help him focused on his new perspective on life. As a result, he was now enrolled in college and two classes away from transferring to a university.
There were many responses from other students who talked about people in their lives who motived them to attend college. Another student stated:

My mother. I mean even though it’s been a while, she, she actually came from Arizona and she got a scholarship to go to UCSD. So she’s big on yeah, you can do it. It doesn’t matter. Don’t worry about money. You can get scholarships (laugh). If she did it we can all do it.

This student witnessed her mother make it through school while raising her family. The amount of hard work and determination her mother displayed motivated her to attend college, not only for herself, but also for the children she now has. As a mother of three, she talked about starting and stopping out of college for a while for the purposes of being a mother of three and trying to attend college. Now that her kids were a little older, she was able to enroll back in college with plans of continuing until she received her degree. Another student also mentioned how his family motivated him to attend college. He stated, “my family because they are, I wouldn’t say strict on education, but they frown upon not having education. So I kind of transitioned from high school to community and then hopefully to a four year.” This student also talked about how he was learning the basics for the first time as a result of not trying in high school. He stated that he regrets not working hard in high school because he was now paying for it in college. Regardless of not focusing in high school, he was now in college and focused so that he could obtain his college degree. Other responses from students were similar to the ones above.

Another female student stated, “Any influences to keep on going is my mother and my relationship with God. That’s it.” This student also mentioned being the first in her family to attend college. That also served as her motivation to not only attend college, but also obtain a college degree. There were similar responses to the ones above. Students talked
about being first-generation college students, parents, and the adversities they had to overcome to attend college. Students connected their personal lives to the people who were in their lives. The relationships they encountered played a key role in their decision to attend college. Seeing them attend college, or not, motivated them to succeed. Students’ take on their challenges differed from the professors: they used their experiences and challenges as motivation to succeed in life whereas professors view students’ challenges as barriers to their success.

**Effective Supports**

Professors and students alike talked about in-class tutor support as a necessity to students’ success. For professors, having tutors inside the classroom was imperative because it allowed students to receive additional support immediately. Also, having tutors inside the classroom helped students become more comfortable and confident in asking questions. For students, having in-class tutors made them feel like they had a chance of actually passing their math class. Additionally, they liked that fact that they received more help and support as a result of having more content knowledge bodies inside the classroom daily. Professors and students both articulated a belief that in-class tutors were instrumental to student success in developmental mathematics.

**Professors’ views on in-class tutor support.** Professors strongly believed that the amount of in-class tutor support available to students was crucial because their support not only helped students with their skills, but it helped students build the confidence necessary to ask for help, ask questions, work with classmates, and gain a deeper understanding of the mathematics. In addition to in-class tutoring and support, students had access and were encouraged to utilize outside resources available to them as
well. Professor Bailey stated, “I do encourage them very much to go to the math center and the tutorial center here on campus.” Professors in this study appreciated the amount of resources available to students at the math-tutoring center. Students whose schedules did not permit them to attend tutoring outside of class had the option of e-mailing their math questions to their professor or the tutoring center. Professor Williams explained:

I think the tutor obviously being in the class is such a big help... More bodies, more instructors. I think the more people, to a certain extent, the better. Not only... because some students are still intimidated by me. So it still is nice to have somebody that they might think of more as a peer. So just having that extra body in there for confidence and answering questions and solidifying concepts, all of that.

Having tutors in the classroom to help support students was helpful, not only for students, but professors as well. For Professor Williams, tutors were extremely helpful with clarifying the mathematics and answering students’ questions because “they want to make sure that everyone’s successful.” Additionally, having tutors in the classroom helped to build confidence in students because tutors were seen as peers, which served as an easier and less intimidating access to getting their questions clarified. Furthermore, having tutors in classroom helped professors reach more students because there were more bodies circulating the classroom. Professor Williams further explained, “Sometimes the students who need help the most aren’t going to ask.” Professor Bailey gives insight on a possible solution for getting students to ask for help. He explained:

It is also important to be really approachable so they are not afraid to ask questions during class because as I tell them I am not psychic. If they are falling behind and not understanding I can’t, I can try and guess based off their facial expressions but that is not very reliable and I don’t want to just call people out if I don’t think they are understanding something. So it’s important that they feel comfortable in class.
Many of the professors and students reported that when students feel comfortable; they are more likely to speak up and ask for help. This type of atmosphere has to be set by the professors. Typically, students feel more comfortable raising their hands to have a tutor or professor approach them rather than raising their hands to ask a question in a whole class setting. For this reason, it may be helpful to have multiple bodies walking around supporting students especially when they understand that the professor and tutors are only there to help them succeed. Once students feel comfortable approaching the professor and tutors, they are more prone to asking questions. They just need assurance in knowing and believing that professors and tutors are actually approachable and really are doing what it takes to help them succeed. Professor Gomez explained:

I give [in-class tutors] a lot of latitude in my classroom, especially the one that has the two extra [tutors]. I have them get into their face, force them to ask you questions, force them to tell you what they are working on, because you have to know what they are working on. So sometimes I do it myself, but right now I am having the two [tutors] really communicate with them in the class because they are interacting so much in the classroom with them.

This implies professors altered their teaching styles to meeting the learning needs of their students by providing access to in-class tutor support, office hours, less lecture time so that students have more in-class time to practice more with the mathematics, and helping them with non-math related school questions. Professor Gomez further explained:

One of the things I find with an accelerated program such as an eight-week course is, it’s time on task. If you’ve got the time, force them to work. Don’t spend all the time lecturing. What’s the point? I mean they’re not going to get any better. And that is the kind of environment that I build. The [in-class tutors] help me build that rapport […] and I commend [them].
Professors took advantage of in-class time and meeting their students’ needs by not lecturing the whole time and giving students the opportunity to build inner confidence in their ability to learn the mathematics and ask necessary questions to further their thinking and understanding. Likewise, professors took advantage of in-class time by allowing students to obtain access to immediate supports (i.e. tutors and peer collaboration). Moreover, having more in-class support allowed students to gain a deeper understanding while making connections with the mathematical concepts in which they engaged. The kind of environment that the professors in this study built for their students showed that they genuinely cared about doing what was necessary for ensuring student success.

Students’ views on in-class tutors. Students found in-class tutors to be an essential support in their math class. In fact, when asked about support(s) they felt would be most beneficial to their learning, most students responded that they would like more in-class SIs/tutors. One female student viewed tutors as a support system that she could use so that she would have a less chance of failing. She explained, “I would choose like tutoring, because like if you don’t understand something and you go through everything with you so there’s no like…there’s like a really small chance that you will fail.”

Another female student wrote:

I would definitely choose the [in-class tutors], because it’s really helpful. But that’s a big thing, that when it’s fresh in your head you need to be able to work through it, not three hours later or two days later. So when it’s right there and you have a question, that you know what your question is. Whereas maybe later on you’re like where was I stuck again? How was I stuck again? So it’s really helpful to have them right there and they’re willing to just come up. Oh yeah, this is how.

Students in this study also found the in-class tutor support beneficial to their learning. Additionally, students felt like they had a better chance of succeeding with the in-class
tutor support. As a result, they took advantage of in-class time to ask questions whenever they were stuck or simply wanted to make sure that they were on the right track. Developing questions not only allowed for students to receive immediate feedback, but also made approaching professors and tutors for support less intimidating. A male student wrote:

To me, tutoring is fine. Tutoring and asking questions. To me that’s it. And the professor. You’ve got the tutors, you’ve got the professor, and you just ask questions on both of them. To me that’s enough. Yeah. That’s all you need.

It is evident that the immediate in-class supports available to students were sufficient enough to build their confidence, change their attitude towards their ability to learn the mathematics, and actually succeed. A female student reported, “I would choose one-on-one tutoring with lots of feedback. I need to have confidence in the ability to succeed in algebra.” While some female respondents mentioned fear, anxiety, and confidence, male students wrote that they needed “more reliable… access to the help [they] needed” or that they simply needed help studying. One male student wrote in “Tutors, obviously.” Although female student mentioned that she would like more tutors, she also mentioned that she needed more time: “Time. Time is the biggest support. I would give myself more time to get the concepts down.” A male student also mentioned that he needed more time. Although their number one support would be more time, both of these students mentioned having tutors in the classroom was a “big help.” The male student explained:

I personally don’t necessarily make too much use of the availability of the tutors. But if they do…I don’t seek them out. But if they do happen to notice that maybe I’m struggling on something, they’ll help me IN class, and that’ll help me to understand maybe what I am missing or misunderstanding. But other than that, I don’t have much of an opinion.
But I do agree that they can be of help, but if a student is lacking or is unaware of a fundamental part of math, it can be a bit difficult.

Although this student does not feel the need to immediately seek help from the tutor(s), he does recognize how valuable tutor(s) are to have inside of the classroom. For this student, tutors are valuable because they notice when he is struggling, provide immediate support(s), and help him to understand any misconceptions that he may have prior to leaving the classroom.

**Summary of Findings**

In sum, this study yielded four key findings regarding students’ and faculty characterizations of students’ learning needs and experiences in developmental mathematics. First, many students, according to the professors, enter college with a lack of confidence in their mathematics ability as a result of their past challenges and experiences with mathematics. As a result, professors sought strategies for helping students develop a growth mindset. Second, professors and students believed that students’ need a lot of in-class time to practice the mathematics they were learning. Third, professors believed that students’ personal lives served as challenges to their success, while students perceived them as inspiration. Finally, professors and students articulated a belief that in-class tutors were instrumental to students’ success in developmental mathematics. The findings were in agreement between professors and students’ characteristics about the need for in-class practice and tutors. The findings differed, however, between professors’ and students’ characteristics around students’ mindsets and the role of their personal lives.
**Finding #1: Mathematical Mindset**

Professors and students expressed different beliefs about mathematical mindsets. Professors articulated a belief that in order for students to be successful in developmental mathematics they entered with a fixed mindset and needed to develop a growth mindset. In contrast, when students talked about their experience learning mathematics, their statements did not talk about or indicate a growth mindset. However, students’ in this study talked about their personal lives as motivation for them to succeed, which caused them to develop and grow as a whole individual.

Professors in this study talked about confidence, not only as a mindset builder, but also being a major factor in how well students perform in developmental mathematics. For example, if students entered college with a lack of confidence in their mathematics ability, then their lack of belief in themselves would affect their performance. As a result, professors in this study believed that part of their responsibility was to do whatever they could to help build confidence in their students. This included helping students to see that they were not “stupid” as a result of “not being good at math” or once being told that they were. Professors believed that they had to help students work around their fear of asking questions, going to the board to solve a problem, working with their classmates, and believing that they were smart enough to learn mathematics that they once thought they were not good at. As a result of students’ past struggles in mathematics or negative words that were used towards them, professors worked hard to help undo the damage that they believed destroyed students’ growth mindsets and confidence in their mathematics ability.
Although some students reported having a positive high school experience learning mathematics, the majority of students described past mathematical learning experiences as extremely difficult. This standpoint stemmed from mathematics always being challenging for them. As a result, students articulated a belief that they were not good at math. Their perceptions of their mathematics ability were connected to how well they performed in their past math classes. Students talked about how they barely passed, or how they failed and had to re-take their math classes in order to graduate high school. Students entered college believing that they were not prepared because they felt that they did not learn all of the necessary tools in high school to help them succeed. Consequently, students entered college with a struggler mindset.

**Finding #2: Skill Development and Collaboration**

Professors and students both articulated a belief that students need substantial time for in-class procedural skill practice and collaboration to be successful in developmental mathematics. All of the professors in this study talked about practice as one of the primary tools students’ needed to be successful in developmental mathematics. Their responses centered on lecturing followed by a lot of in-class example problems for students to practice. They stressed the need for procedural and step-by-step notes as well as example problems for students to try on their own prior to leaving the classroom. Practice, in these classes, looked very similar. Students were given notes, examples that they could practice both individually; followed by practice problems they were given to work out together with their classmates. All of the professors talked about the importance of allowing students to not only practice the example problems, but also to have the opportunity to ask questions in class. The example problems consisted of the same type
of problems given during the lecture with the exception of different numbers so that students could follow the steps with ease. The professors also talked about the need for having in-class breaks. Their idea of an in-class break was related to how they utilized in-class time. Instead of lecturing the whole time, professors in this study allowed students listen to lectures, work on their own, work with their classmates, and work with the tutor(s). Each transition was considered a break because students were not just listening to a lecture for the entire class time. Professors talked about this model of instruction as a benefit to the students because they were given the opportunity to learn what they need to learn in the classroom, while, at the same time interact with each other, ask questions, receive immediate feedback and support from the tutor(s).

Students in this study also believed they needed a lot of practice with the mathematics in order to be successful in developmental mathematics. Students talked about the need to see many examples of the problems being taught and attempting to solve them more than once to help reinforce their knowledge of the mathematics. Students also talked about the benefit of having a lot of practice problems in relationship to their freedom for error. Students in this study felt like they could attempt the example problems even if they were not confident about whether or not they were solving the problems correctly, because they were not being penalized as they would on an actual exam. Students also spoke about the need to actually write everything down and try the problems out on their own although their professor solved the problems in class during the lecture. For students in this study, seeing and hearing lectures were not sufficient enough for them to retain the information. They need a plethora of examples and practice in order for them to retain the information. The pace of the course was also important, as
students needed time to digest what was being taught and what they practiced. Students felt like they were more prepared for their quizzes and exams as a result of having a sufficient amount of time to practice. This is not surprising as a result of students’ past experiences with learning mathematics from a stand-and-deliver procedural skill based approach.

**Finding #3: Role of the Students’ Personal Lives**

Professors and students differed in how they characterized students’ personal lives. Professors articulated students’ personal lives as barriers to their success. Students, on the other hand, articulated their personal lives as motivation to succeed. Professors in this study talked about the need to consider the obstacles students face as a result of their personal lives. Professors articulated a belief that in order to help students to be successful in developmental mathematics that professors need to consider the obstacles stemming from the personal lives of their students. Professors viewed their students lives outside of the classroom as a struggle or challenge (stuck) rather than seeing their personal lives as being overcomers. When talking about multiple obstacles that students face while they are trying to successfully persist through college, professors discussed students as being first-generation, full-time employees, parents, possibly homeless, having past math struggles, and their lack of preparation upon entering college. As a result, professors supported students by directing them to resources that would aid them in their attempt to persist through, not only their class, but through college in general. For example, professors informed students of how important it was for them to have an education plan for the purpose of having direction on classes based on their career goals. Additionally, they talked about other resources that were useful for helping students be
successful as they navigate through college. Professors also connected their reasons for supporting students with resources in addition to mathematics because they felt like it was important to ensure students that helping them navigate the resources available to them based on their career path was equally important to ensuring that the learning the mathematics being taught. In addition to teaching math, professors in this study helped students to be proactive about their college and career path because many of them were first-generation college students so they did not get the necessary guidance from home.

Students in this study used challenges in their personal lives as motivation for them to succeed. As a result, they talked about how overcoming their past obstacles and family support motivated them to attend college. Students faced major obstacles, but instead of allowing their obstacles to cause them to give up, they used them as motivation for moving forward and attempting to make a better life for themselves and their family. The students in this study who were also parents talked about how, although they had to take some time off from school, they returned to college to provide a better life for their children. Their children served as motivation for them to persist through college. There were many responses from students who talked about how members of their family motivated them to attend college. Although their parents did not attend college, they served as motivators for students in this study to attend. As a result of being first-generation college students, parents, and overcoming adversities to attend college, students used all of the above as motivation for doing their best to persist and succeed.
Finding #4: Effective Supports

Professors and students both articulated a belief that in-class tutors were instrumental to student success in developmental mathematics. Professors in this study talked about how crucial it was to have in-class tutor support. They believed that the in-class tutors helped students not only build confidence to ask questions, but also helped solidify mathematical concepts with which they once struggled. For this reason, professors gave the tutors latitude to ask students questions and immediately provide support whenever needed. Professors used the in-class tutors as a way to scaffold and build upon student’s learning experiences because they were seen as more capable peers. As a result, in-class tutors helped reduce students’ fear or intimidation of having to ask questions in a whole class setting and increased their confidence to ask question and receive immediate feedback and support. Also, professors mentioned that in-class tutors were instrumental because the students saw them as a peer-instructor. According to the professors, seeing tutors as peer-instructors allowed students who might have been intimidated by the professor to still receive the necessary immediate support they needed to successfully get their questions answered. When asked what they would do with unlimited resources and funds, one common response among professors was to definitely to hire more in-class tutors.

It is evident that students enter college with various learning styles and needs based on their particular learning need(s). Students articulated a belief that in-class tutors were imperative for their learning and success. In fact, when students were asked for additional support choice, most of them said that they wanted more tutors inside the classroom. Students believed that they were less likely to fail with in-class tutors, indicating a
growth mindset. As a result, they took advantage of the in-class tutor support by immediately asking questions rather than waiting until they got home to attempt to address their questions on their own. Students also articulated a belief that in-class tutor support made it easier to get the necessary support they needed because the tutor(s) were in-class daily to answer all questions, help them study, and provide immediate feedback.
Chapter V: Discussion, Implications, and Final Remarks

Overview of the Research Study

This qualitative study set out to explore and understand students’ learning needs, faculty perceptions of the students’ learning needs, and the ways their instructional practices address students’ learning needs, adding to the current research on community college developmental mathematics. The study also sought to understand professors’ beliefs about their students learning needs, the reasoning behind their lesson planning, and the instructional practices and resources they are using to ensure that the learning needs of their students are being met. Moreover, this study sought to understand strategies for maximizing students’ success in developmental math classes and the interactions between students' social and physical environments that mediate their thinking and understanding of developmental mathematics. In order to effectively understand the above issues, this research was guided by examining the following questions:

1. How do community college students characterize their needs and learning experiences in an accelerated developmental math class?
2. How do instructors characterize the learning needs of their students within an accelerated developmental math class?
3. What instructional practices do the instructors use to meet the learning needs of their students?
4. In what ways do the instructional practices in an accelerated developmental math course match the learning needs of their students?
In order to address these questions I conducted a qualitative study that was guided by the literature on an ecological model, constructivism, zone of proximal development (ZPD), and mindsets. To better understand how faculty and students characterize learning needs of students in developmental mathematics classes, this study focused specifically on faculty and students who were in the three Math 46 courses during the summer of 2015 offered at the same community college. The three classes had an average of 24 students in each class for a total of 73 enrolled students, and 37 students along with the three professors volunteered to participate in the study. Of the 37 students who were initially surveyed, seventeen students agreed to participate in semi-structured or focus group interviews. All three professors agreed to participate in semi-structured interviews. Data was triangulated via field note observations, surveys, semi-structured interviews, and focus group interviews. Triangulation of data involved checking for consistency and accuracy among various sources, was used to reduce biases, and provided a better assessment of how to makes sense of the data (Maxwell, 2013; Mertens, 2010).

**Summary of Principle Findings**

In sum, this study yielded four key findings regarding exploring and understanding how students expressed their learning needs, how faculty viewed the students’ learning needs, and the ways that instructional practices may addressed those needs. The results of this study indicate that there was intersubjectivity between professor and students’ characteristics about the need for in-class practice and tutors. The findings differed, however, between professors and students characteristics around students’ mindsets and the role of their personal lives.
Mathematical Mindset

The overarching finding in this study was that the mindset of our students matter. Mindsets determine our decision-making and how hard we work to be successful in any area of our lives. The power of mindset is its ability, along with support from others, to change a situation based on what one believes (Dweck, 2009). Professors and students expressed different beliefs about mathematical mindsets. Professors articulated a belief that in order for students to be successful in developmental mathematics they need a growth mindset. Professors in this study talked about confidence, not only as a mindset builder, but also being a major factor in how well students perform in developmental mathematics. They believed that students’ past mathematics experiences were the result of them entering college with a lack of confidence in their mathematics ability. Professors believed since many students have always struggled with mathematics and were once called “dumb” or “stupid”, they took on the mindset of a failure which caused them to lose confidence in themselves. This hinders a student’s growth mindset, which causes their fixed mindset to remain stagnant. This type of thinking also “compromises resilience in academic settings” (Dweck, 2009, p. 302). For this reason, professors in this study believed that part of their responsibility was to do whatever they could to develop a mathematical growth mindset as well as help their students build confidence themselves. As a result of students’ past struggles in mathematics or negative words that were used towards them, professors worked hard to help undo the damage that they believed destroyed students’ growth mindsets and confidence in their mathematics ability. The majority of students in this study talked about their past mathematics experiences learning mathematics from struggler’s standpoint. Students talked about how they
struggled a lot, barely passed, or how they failed and had to re-take their math classes in order to graduate high school. Their perceptions of their mathematics ability were connected to how well they performed in their past math classes, which confirmed professors’ perceptions of students’ mindsets. While students past math experiences did not make them feel like they could grow mathematically, their personal lives motivated them to develop and grow as a whole individual.

**Skill Development and Collaboration**

Traditionally, mathematics instruction consists of a teacher-centered, stand-and-deliver approach to student learning. This teaching style consists of teachers telling while students listen and work in isolation with little to no student-to-student interaction (Silver and Smith, 1996). Professors and students both articulated a belief that students need substantial time for in-class procedural skill practice and collaboration to be successful in Developmental Mathematics. They stressed the need for procedural and step-by-step notes as well as example problems for students to try on their own prior to leaving the classroom. Likewise, students talked about the need to see many examples of the problems being taught and attempting to solve them more than once to help reinforce their knowledge of the mathematics. When students are given the opportunity to practice, solve problems, and discuss the mathematics they are learning, their knowledge and computational flexibility will grow (Scharton, 2004). Students in this study talked about the how they benefited from working individually, collectively, with tutors, and professors. They discussed how collaborating with others added to the level of their understanding of the mathematics.
Professors in this study utilized class time effectively by allowing students to not only collaborate with each other and tutors, but also professors used real world analogies to help make connections between students prior knowledge and the knowledge they constructed (Azzarito and Ennis, 2003; McInnerney and Roberts, 2004). When students work together in groups the focus shifts from the individual student as a learner to students working together, as evidenced by the observations in this study. The more students work together to help each other learn, the greater their chances are to develop their language and thought, strengthen their critical thinking skills, and better understand the problems they solve. Students also talked about the benefit of having a lot of practice problems. Practice not only help students better understand the mathematics they were learning, but also gave them the opportunity to learn from their mistakes or misunderstandings prior to taking the actual exam. Students felt like they were more prepared for their quizzes and exams as a result of having a sufficient amount of in-class support and time to practice (Gourgey, 1998). Furthermore, those students who carry out the metacognitive strategies effectively are more successful than those who do not use them. For the purpose of this study, professors allowed time for students to not only practice the mathematics in-class, but also collaborate about the mathematics with classmates, tutors, and the professors themselves. Thus, metacognition and the mindsets of students played a critical role in how students seek to understand and characterize their needs and learning experiences.

**The Role of the Students’ Personal Lives**

Prior research talks about the demographics of students who are typically place into developmental mathematics and the fact that many students are not remediating
successfully (Bahr, 2008; Bahr, 2010; Berenson, Carter, and Norwood, 1992; Fong, Melguizo, Prather, and Bos, 2013; Hagedorn, Siadat, Fogel, Nora, and Pascarella, 1999; Hall and Ponton, 2005; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013). However, a novel finding in this study was that professors and students differed in how they characterized students’ personal lives. Professors articulated students’ personal lives as barriers to their success. Professors perceived students’ lives outside of the classroom as a struggle or challenge. Professors talked about multiple obstacles that students face while they are trying to successfully persist through college. They believed that students were underprepared to not only persist through college, but also to navigate resources beneficial to them. As a result, professors supported students by directing them to resources that would aid them in their attempt to persist through, not only their class, but through college in general. Students, on the other hand, articulated their personal lives as motivation to succeed. As a result, they talked about how overcoming their past obstacles and family support motivated them to attend college. According to Yeager and Dweck (2012), “as students move through our educational system, all of them will face adversity at one time or another, whether it is social or academic in nature” (p. 312). As a result, how one responds to their setback(s) determines the way in which they grow from them. Students faced major obstacles, but instead of allowing their obstacles to cause them to give up, they used them as motivation for moving forward and attempting to make a better life for themselves and their family.

**Effective Supports**

Professors and students both articulated a belief that in-class tutors were instrumental to student success in developmental mathematics. In-class tutors served as a
scaffolding support for students. Professors in the study used the in-class tutors as a way to scaffold students learning needs and experiences (Vygotsky, 1978; 1986). Professors believed that the in-class tutors helped students, not only build confidence to ask questions, but also helped solidify mathematical concepts that they once struggled with. Likewise, students articulated a belief that in-class tutor support was imperative for their learning and success. Students believed that they were less likely to fail with in-class tutor support as a result of the tutor(s) being in-class on a daily basis to answer all questions, help them study, and provide immediate feedback.

In sum, the overarching finding in this study was that students’ mindset play a critical role in their success. Many students enter developmental/remedial mathematics with a fixed mindset, which if not changed may affect their future success. The remaining three findings fall under the umbrella of the overarching finding. Students and faculty not only believed that students need a lot of in-class practice in developmental mathematics, but also they believed that in-class practice linked to progress, which liked to success. Thus, in-class practice mixed with in-class supports and immediate feedback could not only be a solution for helping students develop a growth mindset, but also for helping them persist through the developmental mathematics pipeline. It is imperative that professors are not only conscious of students fixed mindsets, but also have strategies for helping students develop a mathematical growth mindset (Dweck, 2009). Equally important, is having an understanding of students backgrounds and knowing how to teach accordingly. This study supported a growth mindset by introducing an atypical developmental mathematics model of teaching and learning. The findings in this study confirm, based on students and faculty voices, that this atypical model supported a
growth mindset by providing in-class tutors, effective professors, and effective teaching strategies such as: in-class student-to-student group interactions, in-class student-to-professor interactions, and in-class student-to-tutor interactions. Furthermore, this atypical model supported a growth mindset by teaching the course in 8-week extended days rather than the normal 16-week course. This gave students an opportunity to finish their developmental mathematics sequence sooner than expected. Although this study did not track students following developmental mathematics course, students were in fact given the option to continue this atypical model for their remaining courses. Professors in this study believed that students’ past mathematics experiences and personal lives caused students to develop a fixed mindset and lack of confidence in their abilities. Students’ responses, on the other hand, did not specifically discuss developing a growth mindset. However, their stories about their personal lives indicated that they believed in their own growth and potential more generally.

**Contributions to Research and Theory**

In Chapter Four, this study’s findings show that there exist gaps in the research in the field. However, the findings are continuously connected to the theories that guided this research study. In this section I will not only highlight the gaps in prior research in this field in relation to the findings in this study, but also highlight the theories that guided my study as well as the connections between the theories and the findings of this research study. The results from the findings in this study indicate that students need supports, both *inside* and outside the classroom, as they navigate through the developmental mathematics pipeline. These supports are examined from Bronfenbrenner’s (1977, 1994) Ecological Theory, which provides a conceptual
framework to understand how direct influences (i.e. professors, in class tutors, classroom environment) and their face-to-face interactions with the developmental math student work together to help the student persist through the developmental mathematics pipeline. The ecological environment of an individual consists of a set of nested structures, which are designed to work together to help support the developing individual (Bronfenbrenner’s 1977; 1994). In order for this to occur, all nested structures must be aware of the backgrounds, both mathematically and personally, of their students. This implies doing what it takes to learn about their students as a whole and building from that knowledge not only alter instructional practices, but also help support students inside the classroom.

This research study contributed to filling a gap in the literature and our knowledge about students’ learning needs, faculty perceptions of the students’ learning needs, the ways their instructional practices address students’ learning needs by using their voices to shed light on effective strategies for maximizing students’ success in developmental math classes. In contrast to the findings from this research study, many studies from the literature reviewed on developmental math education focus on students being first-time freshman, low-income, students of color (Bahr, 2008; Bahr, 2010; Berenson, Carter, and Norwood, 1992; Fong, Melguizo, Prather, and Bos, 2013; Hagedorn, Siadat, Fogel, Nora, and Pascarella, 1999; Hall and Ponton, 2005; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013). Yet, there are more than just first-time freshman in these courses. Failing to capture the entire view and perspectives of the developmental mathematics picture results in missed opportunities to meet the needs of all students. The factors that contribute to unsuccessful remediation include, but are not limited to: past experiences in
mathematics, limited support or resources, financial hardships, talking care of family, job related obligations, and the length of the developmental math sequence itself (Fong et. al, 2013). What are we doing to ensure that these factors are being accounted for when decisions are made at each institution? Although the literature reviewed addressed demographics and problems centered on developmental mathematics, there still exists gaps in the literature about effective strategies for overcoming the such disparities between students successfully and unsuccessfully persisting through the developmental mathematics pipeline.

**Implications for Future Research**

A limitation of this study is that it used a relatively small sample of students and professors at a single institution. Although students’ and professors’ voices from this study can better help students who place into developmental mathematics, this is not enough to generalize for other populations or institutions. A larger study can further investigate how to help underprepared students successfully persist through the developmental education pipeline in higher education.

In addition, it would be beneficial to explore different teaching and learning models of developmental mathematics such as the model in this study. It is critical that we begin to figure out multiple ways for supporting students inside the classroom. A longitudinal study could also be conducted to not only follow the students who enroll in these different models developmental mathematics classes with in-class supports, but also track their achievement over time and compare to reports of students who experience success to transfer or graduation rates.
Most, if not all, of the research on students in developmental mathematics focus on first-time freshmen. In addition, the research findings on developmental mathematics are not told from the perspective of students or the professors who teach it. Instead, research talks about students in relation to being first-time freshmen, low-income, underprepared, unmotivated, over-represented in remedial classes, and less likely to remediate successfully (Attewell, Lavin, Domina, and Levey, 2006; Bailey, 2009; Bahr, 2010; Harwell, Post, Medhanie, Dupuis, and LeBeau, 2013; Solórzano et al., 2013).

There are more than just first-time freshmen enrolled in developmental mathematics classes. Additionally, more study is needed to not only investigate all of the students who place into developmental mathematics classes, but also studies that seek to understanding their perceptions.

**Implications for Policy and Practice**

**Federal and State Policy**

Results from this study have profound implications for policy makers. Federal and state policy makers must keep up with current research or lack thereof on developmental mathematics. Although there exists a substantial amount of research on developmental mathematics, there exists a gap in the research regarding students’ and faculty voices, perceptions of the current model of developmental mathematics, and strategies for maximizing student success. Although it is clear that remediation works for those who remediate successfully, it is still unclear what factors contributed to students’ inability to successfully remediate. The result of not passing these remediation courses hinders students from obtaining a degree or certificate at a community college and limits their chances of being able to transfer to a 4-year institution and obtain a bachelor’s degree.
Despite the amount of research on developmental mathematics, little is known about the learning needs as expressed by students, the views of student learning needs by faculty, and the ways that instructional practices address those needs. This gap in our knowledge was partly addressed in this particular research study. This is a start, but is not sufficient enough to develop a plan for better supporting students as they attempt to persist through the developmental mathematics pipeline. As a result, state policymakers must put resources into funding the kinds of supports, such as tutors and well-qualified instructors, which were modeled in this study. The current model, stand-and-deliver approach, of developmental mathematics instruction is ineffective because it is not designed to meet students learning needs. For this reason, state policymakers should be funding new approaches similar to this research study.

Furthermore, faculty and students’ are silenced in the discussions, debates, and decision making of mathematics teaching and learning. Educators and students alike should be a primary source for determining what works best for student success. Instead, current policies makers, who often know the least about faculty and student perceptions, beliefs, and needs, serve as the primary decision makers about student success in developmental mathematics. As a result, the deficit thinking about them is that they are not remediating successfully because they have an inability to learn mathematics well. This assumption may be linked to the fact that students experiences and perspectives about their learning ability are not known well. For this reason, the voices of students who are underprepared are needed to help build strategies to maximize their learning needs and success in developmental mathematics. Otherwise, the curriculum, instructional strategies, and policies will continue to reflect and underserve the dominant
race. As a result, this will continue to prolong the goal of dismantling the racial biases, social injustices, inequalities, marginalization, and deficit thinking that hold students captive. Thus, it is imperative that state policymakers figure out an effective way to continually include faculty and students’ voices to help ensure that policies serve and reflect all students who are placed into developmental mathematics. Otherwise, in-class supports for students’ learning needs will continue to be invisible in developmental mathematics.

Strategies on how to improve instruction to meet the needs of students are typically taught in a K-12 teacher credential program. Professors are not required to obtain a teaching credential prior to teaching college. Consequently, they miss important information about strategies on teaching and learning in general, how to lead a student-centered classroom, using students’ prior knowledge and past experiences to guide instruction. As a result, most of them stand and deliver the content without the thought of teaching to the needs of their students. Teaching should evolve just as students are evolving. High quality teaching is a key component for supporting students and ensuring they succeed. One way to ensure that professors have the right tools for supporting students learning and success is to revive the state requirement for a Community College Teaching Credential prior to teaching. Institutions could also provide professors the opportunity and necessary training on strategies for involving students inside the classroom. This includes, but not limited to learning how to use students’ past experiences and backgrounds to inform instruction, know how to scaffold and differentiate for struggling students, form effective groups and student-to-student
interactions, making students feel safe in the classroom environment, and elicit questions that promote critical thinking.

**Community College Leadership**

The majority of professors who teach developmental mathematics classes consist of part-time faculty. Part-time faculty members typically travel to teach in more than one district and/or more than one college. They are not required to attend faculty meetings or hold office hours. An implication for Community College leadership is that they must develop a system for not only ensuring that faculty are aware of how their students learn best, but also for getting them involved in faculty meetings, discussions, and decision makings about developmental mathematics. If Community College leadership better understand the past experiences of their students and their learning needs, then they can work together as a team to ensure that their student are better supported and prepared to persist through the developmental mathematics pipeline. There should be a plan for holding all faculty members, full-time and part-time, accountable for ensuring that they are going beyond the stand-and-deliver approach to support student learning. In addition, the developmental mathematics program itself needs to be re-evaluated.

**Professional Development**

Students who are currently placed into developmental mathematics courses are on the divide, and in a sense, stuck between the way mathematics has been taught and the current change in the way mathematics is being taught. Students talked about their need for procedural skill practice because that is they way they were taught. Now, students in the current K-12 system are expected to critically think, reason abstractly, and justify their thinking and learning using multiple representations. K-12 schools are focusing less
on rote memorization procedural skills. As a result, students pre-Common Core, although they may be stronger procedurally, may have gaps in the area of conceptually understanding and making sense of their mathematics teaching and learning. As the colleges begin to align and focus their teaching of mathematics with the high schools, it is expected that the teaching and learning in developmental mathematics will have a balance between procedural and conceptual teaching and learning.

Although the teaching and learning in this study focused on procedural skill practice, the professors in the study disrupted the developmental mathematics model of teaching by providing an atypical model of teaching via lectures, in-class tutors, and student-to-student interactions. The professors in this study displayed a snapshot of what instruction looks like when teachers are thoughtful about their students learning needs. This atypical model of instruction gives some insights into how district leaders and administration can provide professional development opportunities. Such opportunities for faculty will not only support them in learning about different models of instruction, but also learning how to effectively implement them based on the learning needs of their students. Most professors who teach developmental mathematics courses are part-time faculty, which implies they are not required to attend faculty meetings, attend committee meetings; neither do they have an office to hold office hours. How effective can they be if they are not communicating with the larger faculty community, contributing to dialogue about student learning, or learning effective strategies on how to teach to their students learning needs?

In addition to providing support for professors, there must be an effective system in place for supporting students not only as they transition from high school to college,
but also designed for supporting while they are inside their college classes. Although there exist research programs that are in place at the community college to help students in developmental mathematics courses, they are not designed to meet the needs of students who place into these courses. Many of the students who enter college and are placed into developmental mathematics are first-generation, low-income, students of color. As a result of being a first-generation, students do not have the necessary supports to help them navigate through college or direct them to supports available to them while in college. Colleges must consider ways to continually and effectively support students as they transition from course to course. A solution for helping students navigate college is to develop a support center that students can attend for various reasons. This support center could assist students in various areas such as: studying techniques, job searching, resume writing, organization skills, learning how to prioritize, balancing school and personal life, and tutoring. The professors in this study were supplying most of these supports, but they also need to be available outside of class on a consistent basis. Equally important, according to the findings in this study, is supporting students inside the classroom. In this study, students reported that the number one support that they would want to help them succeed in their developmental mathematics class was in-class tutors. Although there is a tutoring center available to students, the reality is students are balancing between family, work, and school to name a few. The tutoring center does not work for all students. One way to meet students where they are is by providing in-class supports such as tutors. Undoubtedly, students need support inside and outside of the classroom, but more importantly, the supports they receive need to be tailored to their
needs. It’s time to dismantle the one-size-fits all approach to student success. Instead, student and faculty voices need to be at the heart of policy decision-making.

**The Value of Student Voice and Perspective**

This study would not be as powerful had students and faculty voices not been included. Community College leadership must listen to the voices of its faculty members and students on a consistent basis. If the goal of developmental education is indisputably to provide students with the necessary skills for obtaining access, and successfully completing college-level courses and academic programs, then how are decisions being made without listening to their learning needs and lived experiences? Trying to change the cultural stigma of developmental mathematics without seeking to understand the lived experiences and learning needs of that culture results in a cycle of missed opportunities to actually make a difference.

**High School District Leaders, Administrators, and Counselors**

The overarching problem is that few students successfully enter two-year colleges prepared to engage in college-level mathematics classes. Placement levels are determined by placement exams, typically selected by mathematics faculty at each community college. For students who place into developmental mathematics, math is the number one predictor of whether or not they succeed in college regardless of their major. The reason for this is because students’ initial placement level can require them to take up to an additional two and a half years of developmental education or basic skills classes prior to beginning college-ready courses (Solórzano et al., 2013). As a result, placement in developmental mathematics classes at the community college can be seriously disparaging because those classes are not transferrable to a four-year university. For
students who end up with three or more courses below transferrable mathematics, they could be conceivably stuck at a two-year college for three to five years before transferring to a university. For many, the math becomes too much and they never successfully complete or transfer.

Students in this study talked about being underprepared, not only for the mathematics, but also for knowledge about college and the placement exam in general. Many of them mentioned not knowing about the math placement exam until the day they actually enrolled in college. While, others talked about not hearing about the college placement exam until weeks before graduating. How do we better prepare our students as they transfer to college? To better prepare our students for college and the placement exam, district leaders, administrators, and counselors must play a more engaged role in communicating college requirements to students. To help make the transition from high school to college smoother for students, high school and college districts need to communicate on a continuous basis. We need continuous collaboration between high school and college educators so that we are aware of students past experiences and prior knowledge. It is vital that we no longer operate in silos, but instead make room for open and constant communication between the different institutions.

In addition, students need to receive college readiness counseling throughout their entire senior year, not weeks prior to graduating. It would be worth it to invest in a full-time college advisor per campus to assist students. This advisor would be responsible for assisting students with college applications, biographies, resumes, and becoming knowledgeable about the placement exam. How do we better prepare our students for the college placement exam? Developmental mathematics includes mathematics that students
should have completed in high school. These courses range from basic mathematics (adding and subtracting) to Intermediate Algebra or Algebra II. As a result of the shift to Common Core State Standards, these course titles might have changed, but the standards that students are expected to master by the time they graduate have not.

It is important that students not only receive guidance and information about the process for applying to college, but equally important is students being prepared to take the college placement exam. Many students in this study talked about not being prepared for the placement exam. As a result, many of them did not study. For those who studied, they did so at the last minute because they found out about the exam a few weeks prior to graduating. There must be a better system in place for preparing our students for college success. One recommendation would be to (pre) test students at the end of their junior year to determine where they would place in college. Then, use their senior year to remediate students based on their placement score. After remediation during their senior year, (post) test students again to measure growth. Finally, counselors and the community college advisor can use students (post) test scores to advise them on next steps prior to taking the actual college placement exam. The goal should not just be able getting students to graduate, but also about preparing them for post-secondary education.

**Final Thoughts**

A primary aim of this study has been to use students and faculty voices to provide insight into the mindset and perspectives of the individuals who have the power to make the greatest impact on changing the stigma of developmental mathematics. The only way to effectively understand strategies for maximizing students’ success in developmental math classes is to put yourself in their shoes, which implies observing these classes,
listening to students and faculty, and use their input to make a difference. At the end of each college course taken, students are asked to submit an evaluation form of the faculty. Why are we just evaluating faculty? There is much more to be evaluated, which include but are not limited to: understanding students’ learning needs, faculty perceptions of the students’ learning needs and their teaching and ways their instructional practices address students’ learning needs, the developmental mathematics program itself, the campus climate, the effectiveness of resources available to students, and solutions for improving student experience as a whole. It is time to dismantle the one-size-fits-all approach to teaching and learning. Once we are able to evaluate the system as a whole and change it based on the current needs of our students, then we will clearly see that one size does not fit all; it fits few.

It is evident that we all come from different cultures and backgrounds, and have different experiences. As a result, we have different perspectives not only about life, but also about our ability to learn and maneuver through our world. Many of students who place into developmental mathematics are low-income, underprepared, students of color, and many are not equipped with the necessary resources to help them persist through college. Students of color are overrepresented in developmental math classes, and they are less likely to remediate successfully (Bahr, 2010). It may be the case that students of color are underprepared because they attend under resourced schools in elementary, middle, and high school. For this reason, it is imperative that our post-secondary education system pick up the baton, which may have been dropped as students transitioned from elementary to middle school to high school, and support students as they attempt to finish their race not only through the developmental mathematics
pipeline, but also throughout college. One way to achieve this is by listening to students' learning needs and lived experiences and using their voices and perspectives to provide them with the necessary skills for obtaining access, successfully completing college-level courses, academic programs, and achieving their dreams. Many complain and talk about the need for a change in developmental mathematics; but ask yourself, “what am I doing to be a part of the change?”
References


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Appendix A: Community College Mathematics Student Survey

Note: This survey is part of the larger study and has already been approved by IRB.

Thank you for participating in this survey! The results will be kept strictly confidential.

1) What is your gender?
2) What is your race/ethnicity? Check all that apply.
   □ Hispanic or Latino
   □ American Indian or Alaska Native
   □ Asian
   □ Black or African American
   □ Native Hawaiian or Other Pacific Islander
   □ White
   □ Other: □
3) What is your age?

4) What high school did you attend?

5) What is the name of the last math class you took in high school?
   □ Algebra
   □ Geometry
   □ Intermediate Algebra (Algebra 2)
   □ Finite Math
   □ Pre-Calculus (Math Analysis)
   □ Pre-Calculus Honors (Math Analysis Honors)
   □ Calculus
   □ AP Calculus
   □ AP Statistics
   □ Other: □

6) What grade were you when you took your last math class in high school?
   □ 11th
   □ 12th
   □ Other: □
7) What grade did you receive in that math class?
   - A+
   - A
   - A-
   - B+
   - B
   - B-
   - C+
   - C
   - C-
   - D+
   - D
   - D-
   - F

8) What was your high school experience like, particularly with math?

9) What is your current college GPA?
   - 3.5 - 4.0
   - 3.0 - 3.49
   - 2.5 - 2.99
   - 1.5 - 2.49
   - 1.0 - 1.49
   - First semester

10) What was the name of the first college math course you enrolled in?
    (Example: Pre-Algebra)

11) How many units are you currently taking?
    - 0 - 6 units
    - 7 - 12 units
    - Other: [ ]

12) How many units were you enrolled in your first semester at this college?
    (Skip if this is your first semester in college)
    - 0 - 6 units
    - 7 - 12 units
    - Other: [ ]
13) Do you feel the community college math placement test correctly placed you in the appropriate math class? Why, or why not?

14) When you study, do you usually study:  
(Check all that apply)  
☐ Alone  
☐ With a friend  
☐ With a study group  
☐ At the library  
☐ At the tutoring center  
☐ I don't study  
☐ Other:  

15) In general, how many hours do you typically study per week for your math class?  
☐ 0  
☐ 1-3  
☐ 4-6  
☐ Other:  

16) Have you ever visited the math-tutoring center for an appointment with a tutor? If so, how would you rate the type of support you received?  

1   2   3   4   5  
Not at all helpful ☐ ☐ ☐ ☐ ☐ Extremely helpful ☐ ☐ ☐ ☐ ☐

17) How many times, during a semester, do you meet with your math professor during his/her office hours?  
☐ 0  
☐ 1-3  
☐ 4-6  
☐ Other:  

18) Can you describe the type of learning style that works best for you?  

19) In what ways does your math instructor’s teaching style match your learning style?  

20) In what ways does your math instructor’s teaching style differ from your learning style?  

21) If you could choose any supports to help you in your math class, which would you choose? Why?
Appendix B: Adult Student Consent Form

Hello Everyone,

Dr. Susan Yonezawa and Tracey Kiser are researchers at the Center for Research in Educational Equity, Assessment and Teaching Excellence (CREATE) and Education Studies Department at UC San Diego. This summer we are studying the math class you are taking. We are asking for your permission to include you in our study. Your participation in the study is voluntary. You do not have to participate. All of the students who are taking your math class this summer will be asked to participate. There will be up to 120 students asked to participate in the study. You can take the course and not participate in the study. If you agree to be in the study, we would have you:

1. Participate in a brief survey that should only take 15 to 20 minutes of your time. The survey will ask about you, your schooling experiences in high school, specifically around math, and your future aspirations. The survey would be filled out in your math class.

2. We may ask that you also participate in a focus group (45 minutes) with approximately 3 or 4 other students at a time that works for you, most likely right after class. During the focus group, we will ask questions about the math class – your experiences and thoughts about how it is going – and how it does or doesn’t feel compared to high school. We’d like to audio-record the groups. If you do not want to be audio-recorded, but others in the group do, the researcher will talk with you and any other students who also do not want to be audio-recorded at a separate time and take notes instead of recording. We will only need about 2 focus groups per class, so we will randomly select who gets to participate in these if we have more students who agree to do so than we can include.

3. Allow us access to your MDTP (math test) data that your professor will have you take as part of your math course as well as your math course and final test grades and scores.

We will keep all your information confidential. No one outside of the study will have access to this information. Other students and teachers will not see your information. And we will not (nor are we allowed to) share any of this information with other people with your name attached.

What happens next?

When the study is all over, we plan to work with Gateway college officials, professors, and high school administrators and teachers to share the study’s results. All sharing will combine students’ information together; so your individual information will never be shared. We may also share the study at scientific meetings and in written papers. Your name will never be used in any of these reports.
Participation in research is entirely voluntary. You may refuse to participate or withdraw or refuse to answer specific questions in an interview at any time without penalty or loss of benefits to which you are entitled. You can withdraw from the study by telling the researcher present or by contacting Susan Yonezawa at syonezawa@ucsd.edu.

Being part of this study might make you feel a bit uncomfortable at times. You might even get bored when participating in focus groups. Also, others in the group could share what you said. We will try to make sure that doesn’t happen by not linking your name with any recordings or grade/test data and helping everyone participating understand the need to protect what people share. There may be some risks that we can’t yet predict. If risks emerge, Susan and Tracey will let you know, and you can decide if you want to still participate.

The research team reserves the right to remove you from the study if they decide doing so is in your best interest. If, for example, participating is somehow distracting you or if you act in inappropriate ways to other students.

If you decide you no longer wish to continue in this study, you can let Susan Yonezawa or Tracey Kiser know by telling them or emailing Susan at syonezawa@ucsd.edu.

At the end of the study period, all data collection will be destroyed.

**Benefits:** There are no direct benefits to you for participating in this study. But the study in general will help the research team figure out how to better use this kind of course to help students reach transferable math. There are no costs to you for participating in this study.

**Participation in research is entirely voluntary.** The alternative to participation is not to participate.

**Compensation:** If you decide to participate in the focus group, you will get a $5 food or beverage gift card for participating. You will get no compensation for participating in only the survey or providing test and grade data.

**Agreement to be in the Study:** The research team has explained this study to you and answered your questions. Please direct questions or problems to Susan Yonezawa at CREATE at UCSD (858) 822-2271. If you are hurt as a result of participation in this research, the University of California will provide medical care need to treat injuries. The University will not provide any other form of compensation if you are injured. You may call the UCSD Human Research Protections Program Office at (858) 657-5100 to ask about your rights as a research subject or to report research problems. You have received a copy of this form.
Audio-recording Permission

Audio recordings will be used during focus groups to capture more accurately the researchers’ conversation with students. If you give your permission to be audio recorded during the focus group, sign below. By signing below you are agreeing only for the use of the audio recordings as described in form above. No other use of the recordings is allowed. You have the right to request that recordings of you be stopped or erased at any time.

I consent to be audio-recorded during the focus groups.

Your Signature ____________________________________________

Your name (please print) _________________________________
Appendix C: Professor Semi-structured Interview Questions

Hi! My name is Tracey Kiser; I am a doctoral student at UCSD and a full-time High School Mathematics Teacher in the Sweetwater Union High School District. I want to thank you for agreeing to this interview and letting me observe your classroom. I am not evaluating your practice. My goal is to figure out better ways to support teachers and students. As a result, I am seeking to understand, explore, and represent your ideas and perspectives of developmental mathematics, student learning needs as they pertain to these courses, and the ways that instructional practices address those needs. Let’s start by giving me a little background information.

**Background elicitation:** “Let’s with a little background information.”

1. Tell me about yourself as a math teacher here at Gateway College.
   - How many years have you been teaching at Gateway College?
   - How did you become a professor at Gateway College?
   - Have you taught other classes besides this class? (If yes) What other classes?
   - Are you full-time here? Do you teach anywhere else?
   - (If part-time) Do you like being an adjunct?

**Student needs elicitation:** “To a fellow math teacher, can you talk to me briefly about…”

2. What do you see as key instructional practices that you engage in teaching developmental math?
   - (After explanation) What made you think of using that as an instructional practice?
   - How do you decide on what strategies to incorporate for your lessons?
   - Are there other instructional practices or strategies you use in other classes? (If yes) How do you decide which instructional practices/strategies to use in each class?

3. What type of instructional practices/supports do you believe students need to be successful in this class (developmental mathematics)?
   - In college in general?

“Ok, let’s switch over to students.”

4. In thinking about students, what tips you off that students aren’t getting it?
   Examples?
   - What do you do to support the student?
   - Anything else you notice about struggling students?
5. Think about the class you taught in the spring, what were some of the typical supports you provided for students? Examples?

6. What tips you off that students have mastered a topic?

7. In what ways does your teaching style match your students’ learning style?

8. In what ways does your teaching style differ from your students’ learning style?

**Teaching philosophy elicitation:** “If someone were to ask you…”

9. What kind of teacher are you, what would you tell them?

10. “In some institutions some professors who teach the same courses collaborate regarding those courses while other don’t.” How does it work here?
    - Do you meet with colleagues to discuss and plan curriculum or teaching strategies? If so, how often do you meet?

**Autonomy and constraints elicitation:**

11. “Sometimes community college professors have a lot of freedom in organizing their classes and others don’t…” What about you?
    - How much freedom do you have with teaching this course?

12. “Sometimes community college professors feel like there are a lot of constraints that prevent them from teaching what they would consider their best classes…” What about you?
    - What constraints keep you from teaching an ideal lesson?

**Final questions:**

13. You wake up tomorrow morning and are in charge of developmental mathematics with unlimited resources, what is the first change you would make? Next? Why?

14. What else would be helpful for me to really understand your teaching of developmental mathematics?

15. Is there anything else you would like me to know about your ideas, perspectives, and instructional practices regarding developmental mathematics, or student learning needs as they pertain to these courses?

**Thank you for your time!**
Appendix D: Adult Professor Consent Form

Hello,

Dr. Susan Yonezawa and Tracey Kiser are researchers at the Center for Research in Educational Equity, Assessment and Teaching Excellence (CREATE) and Education Studies Department at UC San Diego. This summer we are studying the math class you are teaching. We are asking for your permission to include you in our study. Your participation in the study is voluntary. You do not have to participate. You are receiving this request to participate in this study because you are one of the professors teaching this course.

If you agree to be in the study, we would have you:

1. We will contact you via email or in person to set up a meeting to conduct classroom observations. The classroom observations will be audio recorded only if you have given permission and have agreed to participate.

2. We will arrange a time to meet with you for an approximately 45-60 minute interview. We will ask you questions about your lesson plan, teaching practice, and how they relate to student learning. You are not required to answer any questions during this interview. We will audio record the interview only if you have given permission and have agreed to participate.

We will keep all your information confidential. No one outside of the study will have access to this information. Other professors will not see your information. And we will not (nor are we allowed to) share any of this information with other people with your name attached.

What happens next?
When the study is all over, we plan to work with Gateway college officials, professors, and high school administrators and teachers to share the study’s results. All sharing will combine professors’ information together; so your individual information will never be shared. We may also share the study at scientific meetings and in written papers. Your name will never be used in any of these reports.

Participation in research is entirely voluntary. You may refuse to participate or withdraw or refuse to answer specific questions in an interview at any time without penalty or loss of benefits to which you are entitled. You can withdraw from the study by telling the researcher present or by contacting Susan Yonezawa at syonezawa@ucsd.edu.

Being part of this study might make you feel a bit uncomfortable at times. There may be some risks that we can’t yet predict. If risks emerge, Susan and Tracey will let you know, and you can decide if you want to still participate.
If you decide you no longer wish to continue in this study, you can let Susan Yonezawa or Tracey Kiser know by telling them or emailing Susan at syonezawa@ucsd.edu.

At the end of the study period, all data collection will be destroyed.

**Benefits:** There are no direct benefits to you for participating in this study. But the study in general will help the research team figure out how to better use this kind of course to help students reach transferable math. There are no costs to you for participating in this study.

**Participation in research is entirely voluntary.** The alternative to participation is not to participate.

**Compensation:** Professors who participate in the interviews will not receive any compensation.

**Agreement to be in the Study:** The research team has explained this study to you and answered your questions. Please direct questions or problems to Susan Yonezawa at CREATE at UCSD (858) 822-2271. If you are hurt as a result of participation in this research, the University of California will provide medical care need to treat injuries. The University will not provide any other form of compensation if you are injured. You may call the UCSD Human Research Protections Program Office at (858) 657-5100 to ask about your rights as a research subject or to report research problems. You have received a copy of this form.

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<tr>
<th>PARTICIPANT'S SIGNATURE</th>
<th>NAME OF PARTICIPANT</th>
<th>DATE</th>
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<tr>
<th>SIGNATURE OF PERSON WHO EXPLAINED THIS FORM</th>
<th>DATE</th>
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**Audio-recording Permission**

Audio recordings will be used during semi-structured interviews to capture more accurately the researchers’ conversation with the professor. If you give your permission to be audio recorded during the interview, sign below. By signing below you are agreeing only for the use of the audio recordings as described in form above. No other use of the recordings is allowed. You have the right to request that recordings of you be stopped or erased at any time.

I consent to be audio-recorded during the semi-structured interview.

Your Signature ____________________________________________

Your name (please print) ____________________________________
Appendix E: Proposed Student Focus Group Interview Questions

Focus group protocol:

1. **Explain the purpose of the interview**: Thank you for taking the time to participate in this focus group interview. The purpose of this interview is to identify strategies for maximizing first-year students’ success in math classes. As a result, we want to understand what supports, resources, and types of learning you believe you need in order to be successful in your math class. During this focus group, we are going to ask you questions about the math class – your experiences and thoughts about how it is going – and how it does or doesn’t feel compared to high school. We’d like to audio-record the groups. If you do not want to be audio-recorded, but others in the group do, the researcher will talk with you and any other students who also do not want to be audio-recorded at a separate time and take notes instead of recording.

2. **Consent Process**: In all cases, tell participants: Before we begin the interview, we want to remind you that participating in this study is completely voluntary. We will keep all your responses and information confidential. No one outside of the study will have access to this information. Other students and teachers will not see your information. And we will not (nor are we allowed to) share any of this information with other people with your name attached. At any point during the interview, if you would like us to turn off the recorder, just tell us to do so. Do you have any questions about the interview before we begin?

*** Start Recording***

This is a focus group with students from the _______ math course at Gateway Community College, run by UCSD. Tracey and Susan are the focus group facilitators.

There are _____ students -- _____ female and _____ male.

**Background:**

1. Can you start off by telling me where you went to high school and what your high school experience was like, particularly with math?

2. How about you? What school did you go to?

3. What’s your last math class you took in high school?
4. Just in one sentence, what kind of student were you when you were in high school?

5. What about after graduation? What did you plan to do after you finished high school? When you were in high school what did you plan to do?

6. You’ve had a little taste of college now, right? What did you know about college back then? Did you know anything about college? Did you have any experience?

7. What did you know about college?

8. Was there someone who’s been really influencing you, anybody in your life, to go pursue college?

**Placement exam experience:**

9. Can you tell me about your placement exam experience, for the placement exam (math specifically)? What was it like for you? Did you take it in high school or did you take it after?

10. Did you have any preparation prior to taking the test? Did you have time to study for the test at all? What was explained to you about the test? Did you have any information on the Accuplacer prior to taking the test?

11. So if you could go back and do it again, like go back to maybe a couple weeks before you actually walked in to take the Accuplacer, would you do anything differently? Or would you kind of operate the same way?

12. What about taking a senior year of math? Would you go back and take math your senior year?

13. Did you understand what the placement test was for and how it would impact you?
Impressions of the course:

14. I just want to make sure we hear your impressions about the course, too. What was explained to you about this class that you’re in now?

15. What do you think of the course?

16. How do you feel about having tutors in the classroom and how does that relate to your past experience which is having one teacher in the classroom?

17. Is there something that has happened in the class that has worked particularly well for you personally that you’re like, “This. When he/she taught this, this way, I finally was like Oh, my God, I understand it.” Or “When the tutor came up and explained …” Is there a moment where you can think back in the last few weeks where you remember like, “OH, okay. I got that now.” And what happened to lead to that moment?

18. So problems and assignments you’re getting -- the worksheets, all of those kinds of things – do they seem any different than stuff you did in high school? Or do they seem very similar?

General Supports:

19. What do you do when you need help in school? Who do you talk to, who do you go to for help?

20. Who do you go to first, in this class?

21. What about in school in general?
Course specific supports:

22. What’s the difference between this class and your classes in general?

23. So if a class like this is going to exist next semester for Gateway College students coming through, what would you change about the course? What would you keep the same?

24. How is the class designed?

25. Do you have homework in this class?

26. Do you study for the exams and the quizzes?

27. How often do you study?

28. The class is not over yet, but with the experience of this class, what are your expectations of your next class? What are you expecting? What type of instruction do you expect to have in your next course; given the experience you had this summer?

29. Have you heard anything about math here? Any strategies for making sure you get a good instructor?

Learning styles:

30. Can you describe the type of learning style that works best for you?

31. In what ways does your math instructor’s teaching style match your learning style?

32. In what ways does your math instructor’s teaching style differ from your learning style?

33. If you could choose any supports to help you in your math class, which would you choose? Why?