SUPPLEMENTAL MATHEMATICS AT MIDWESTERN COMMUNITY COLLEGE: A QUALITATIVE CASE STUDY

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Abstract: This is a qualitative study that explores how successful supplemental mathematics instructors prepare their students for on-level mathematics, that is taken as a corequisite, at a rural Midwestern community college. Using the Zone of Proximal Development with educational scaffolding as a theoretical framework, this study considers how scaffolding prepares students to become independent learners. Findings suggest that educational scaffolding helps students become independent learners and successful in their on-level mathematics class.

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CHAPTER I

INTRODUCTION

In 1636, one of the country's oldest universities, Harvard University, was founded in Cambridge, Massachusetts. At that time, universities were designed for and attended by members of the nation's elite and upper classes, with admissions based on race and gender (Neklason, 2019). A number of subsequent world events, such as WWII and the American Civil Rights Movement, changed access to higher education, making admission available to a more diverse population. Several laws and reforms were implemented to provide access to marginalized groups, enhancing the diversity of student populations in colleges and universities across the United States. One of the reforms is the Civil Rights Act of 1964, which prohibited discrimination based on race, color, religion, sex, and national origin. This legislation helped to strengthen the desegregation of schools, thus allowing for more diversified student bodies in higher education across the nation. However, many previously marginalized groups struggled to pay for college (Kromydas, 2017). Consequently, Pell Grants, college tax credits, and reforms to the student loan process were introduced to provide the financial support that would enable marginalized groups to enter college.

In reaction to the needs created by a student population that was more diverse in

terms of gender, ethnicity, and socio-economic and educational backgrounds, community colleges were founded. The first community college, Joliet Junior College, was founded in 1901 in Joliet, Illinois (Joliet, 2016). Its mission is to inspire learning, strengthen communities, and transform the lives of students. This mission aligns with the expansion of higher education to serve populations whose home communities may struggle with crime and economic hardships. Since 1930, such colleges have proliferated across the United States (Trainor, 2015) and, as of 2020, 900 community colleges were in operation.

Students entering community colleges come from increasingly diverse backgrounds and display different levels of preparedness. In fact, many entrants are unprepared for the demands of a college level curriculum. Students often lack the necessary skills because of an inadequate academic foundation, limited support systems, and low standards in public schools (Butrymowicz, 2017). Consequently, many students entering community colleges face academic challenges, which include an inability to do mathematical reasoning (Rutschow, 2019). Such students are often in need of remedial coursework.

Considering the many academic challenges that students face when entering community colleges, these institutions have created supplemental courses to support student success in many general education requirements such as mathematics, English, and science. A supplemental course typically ranges from one to two credit hours, is taken at the same time as the college-level course and is designed to support student success in the college-level course (Kenney & Kallison, 1994).

Students often take supplemental mathematics in courses such as College Algebra and Math Functions (Bonham & Boylan, 2012). The students will begin by taking an

exam, usually the ACT, to determine if they need supplemental support or if they are ready for college level course work. If a student scores too low on the math section, they will be placed in a supplemental course and the on-level course simultaneously. The supplemental courses are considered zero level courses, can range in credit hours, and do not count toward the student's grade point average (GPA) on their college transcript. The on-level course is three credit hours and counts toward their GPA.

Supplemental courses are designed to help students succeed in their credit coursework; however, many of the students enrolled in supplemental courses have different rates of success in their on-level course. A student is considered successful if they earn an A, B, or C in their on-level course (Kenney & Kallison, 1994). Some community colleges report an almost 78% success rate for students who are enrolled in Supplemental College Algebra and College Algebra, while others achieve only have a 63% success rate (Otto, 2019).

The differences in success rates could be the result of a wide range of factors, which include services offered on campuses such as tutoring, study skills workshops, and academic advising. Other factors that influence student success are class size, mode of instruction, and classroom environment (Johnson, 2010).

Problem Statement

Since the opportunity to attend college has become a reality for a more diverse student population, students often enter community colleges with a wide range of skills and backgrounds (Baime & Baun, 2016). Many entrants lack the skills or level of understandings required for success in college courses. Specifically, many students lack college-level mathematical skills because of problems associated with poorly funded

education in high-poverty areas and teacher quality in underfunded schools (Peske & Haycock, 2006). Students from underfunded high schools are often underprepared for college-level math because they often did not receive the support that they needed in their math courses (Peske & Haycock, 2006).

Mathematics and Freshman Composition are the two courses that pose significant challenges to students entering college (Lagerlof & Seltzer, 2012). These courses are required and are fundamental for success throughout college. To support student success in these courses, many community colleges have established remedial courses, referred to in this study as "supplemental courses" to support student learning. The typical design of college level courses is for students to receive instruction during class meetings, but they are responsible for their individual progress and performance on class assignments and exams, with limited additional support from the instructor. However, supplemental courses provide the support that students need as they learn the material and move from dependence on the instructor to independent learning. These courses are provided in parallel with the college-level course, and emphasis is placed on foundational knowledge.

Despite such consistent support through supplemental courses, some students experience success in college classes (Altomare & Moreno-Gongora, 2018) and while others do not (Phelps & Evans, 2006). It is important to understand why some students are successful and others not because a support program that does not meet the needs of the underprepared student could prevent them from progressing and, ultimately, from completing college.

Course design is a possible explanation for the success of some students and the failure of others. Specifically, if courses are scaffolded to transfer responsibility for

learning to students after they have developed the required skills, rather than transferring responsibility too early in the process, students would have the opportunity to acquire the skills needed for success (Verenikina, 2003). Vygotsky's Model of the Zone of Proximal Development provides a framework to understand how scaffolding supports student success in the classroom as they move from dependence on help from the instructor to more independent work.

Purpose of the Study

The purpose of this study is to explore, through the lens of Vygotsky's Model of the Zone of Proximal Development, how successful instructors of supplemental mathematics courses in Midwestern Community College prepare students for on-level mathematics coursework.

Research Questions

1. How does educational scaffolding in supplemental mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?
2. What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?
3. What factors or teaching strategies used in supplemental mathematics do students credit for their eventual success in on-level mathematics courses?
4. How do students describe the preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?

5. How are the scaffolding techniques of cognitive structuring, questioning, feedback, instruction, and modeling utilized in these successful supplemental mathematics classrooms?
6. What barriers exist that might prevent instructors from using educational scaffolding?

Epistemological Perspective

The epistemological perspective of this study is constructivism. According to Crotty (1998), constructivism is the truth that comes from engagement with the world. Crotty also stated that "meaning is not discovered, but constructed" (Crotty, 1998, p. 9). Scholars of education further define constructivism as the process through which students construct new knowledge by integrating it with what they already know. The role of the supplemental teacher is to help students build their understanding of mathematics through this process of integration. In this study, knowledge will be constructed by observing the interactions between instructors and students in the supplemental mathematics classroom and the ways in which those interactions change and reconstruct lessons, teacher strategies, and content to help students prepare for their on-level course (Alzahrani & Woolard, 2013).

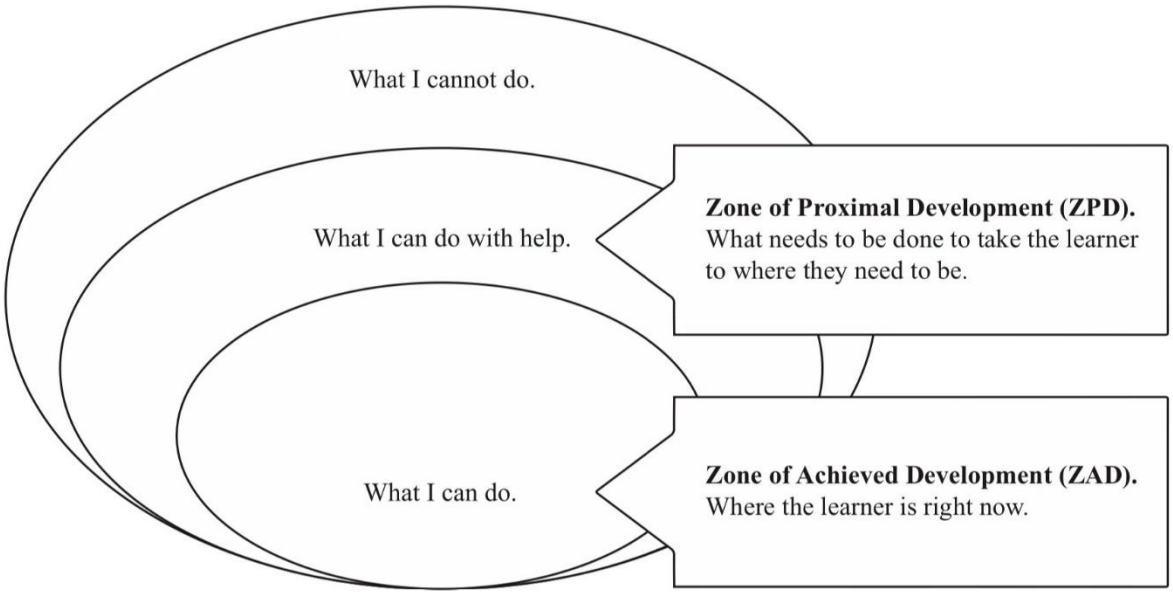
Theoretical Framework

The theoretical framework for this study is the Zone of Proximal Development, a model developed by Vygotsky (1978). The Zone of Proximal Development is defined as "the difference between what a learner can do without help and what he or she can achieve with guidance and encouragement" (McLeod, 2019). The Zone of Proximal Development describes the phase of development where students can perform a skill or

task with support from the teacher with the intent to eventually gain independence from the teacher. Vygotsky's Zone of Proximal Development has utility to explain what the teachers are doing to help students become independent in mathematics because it identifies the student's proficiency level and what they need to achieve to become independent. The Zone of Proximal Development is illustrated in Figure 1.1.

Figure 1.1

Vygotsky's Model of the Zone of Proximal Development



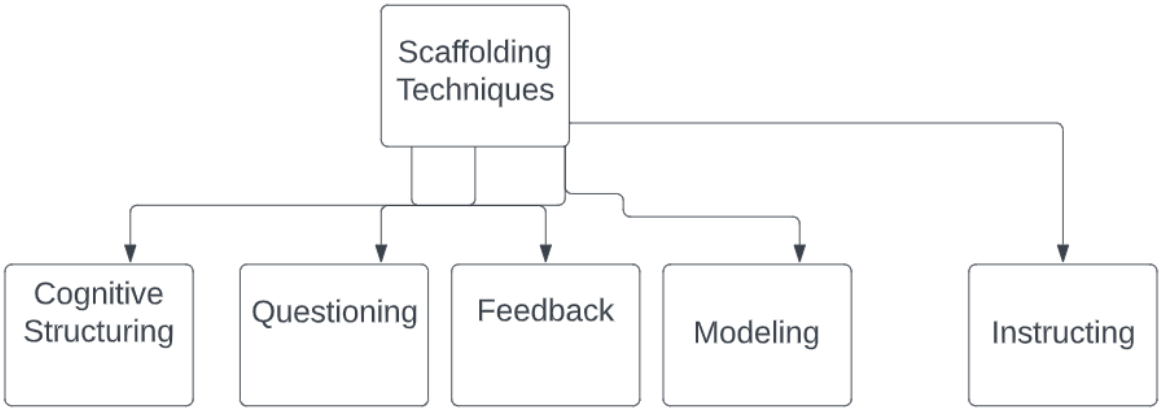
Note. Adapted from Khan (2017). *Mathematics proficiency of primary school students in Trinidad and Tobago*. Teachers College, Columbia University.

Vygotsky's model supports the importance of educational scaffolding. Educational scaffolding is a tool or a set of techniques used by teachers that provide successive levels of support to help a student increase their level of understanding. With

scaffolding, teachers use a variety of supportive mechanisms to help students learn. The teacher then gradually takes away those supportive mechanisms until the support is no longer needed. Figure 1.2 provides an overview of techniques used in educational scaffolding.

Figure 1.2

Scaffolding Techniques



Note. These are scaffolding techniques that can be used to navigate through the Zone of Proximal Development.

The Zone of Proximal Development provides a model for understanding how educational scaffolding supports students to become independent learners. This framework has utility to explain how supplemental mathematics teachers prepare students for their on-level mathematics course because it explains steps and educational scaffolding techniques that can be utilized to help students progress from dependent learner to independent learner. The teacher starts by assessing what the student already knows and setting goals for learning that correspond to what the student cannot do

independently yet. The teacher then provides the student with support measures, which aligns with "what I can do with help" (Vygotsky, 1978). These support measures are educational scaffolding techniques that include modeling, feedback, cognitive structuring, questioning, and instructing. Finally, the teacher fades out the support until the student is working independently, which corresponds with "what I can do," sometimes called the Zone of Achieved Development.

Procedures

To answer the research questions, a qualitative methodology with a case study design was utilized. The case study allowed for a more thorough exploration of a real-life situation (Crowe et al., 2011). A case study exists within a bounded environment and provided me, the researcher, with multiple ways to collect data. Many data options exist in qualitative research. I collected data by means of interviews, observations, and the collection and analysis of documents used for and produced by supplemental group-work activities (Stake, 1995). I interviewed supplemental mathematics teachers and supplemental mathematics students. This range of data collection methods allowed me to take a holistic view of the learning process in supplemental math classes and identify the unique teaching and learning processes that occur in such classrooms (Stake, 1995).

Biographical Information

I have been teaching supplemental mathematics courses at various universities in the Midwest for the past nine years. As an active teacher of supplemental math, I am a supporter of such support programs. This position may have resulted in a degree of bias in my research. In addition, I may have been influenced by my prior experience teaching support classes (Stake, 1995). To diminish bias, I collected data from the main campus of

Midwestern Community College only, not from the satellite campus. I have never taught at the main campus. In addition, I ensured that none of the interview questions are leading questions. Furthermore, I addressed the issue of bias through a process of triangulation. Triangulation in this study is defined as the use of many datasets to answer the research question, which improved the validity and credibility of the findings (Merriam, 1998). In addition, by collecting and analyzing a high number of datasets in my research, I reduced the possible interjection of bias.

Methods

Population

Through the lens of Vygotsky's Model of the Zone of Proximal Development, I explored how supplemental mathematics courses at Midwestern Community College prepare students for on-level mathematics coursework. I used purposeful criterion sampling, which allowed me to select information rich participants to help answer the research questions of this study. My population was drawn from Midwestern Community College [a pseudonym], a community college in Oklahoma. This community college consists of three campuses with approximately 3,000 total students. I selected this population because Midwestern Community College is a community college that utilizes supplemental courses to support student learning in college level courses. The fact that supplemental courses are offered in mathematics allowed me to locate participants who had the characteristics required by my study. My research population included students and teachers to ensure that different perspectives on the functioning of supplemental courses are examined.

Sample

The sample is a subset of the population. In this study, the sample was intended to include three students in two different supplemental mathematics courses and their teachers, for a total of eight participants from the main campus. I selected two instructors who were considered successful because a large percentage of their students in supplement are passing their on-level mathematics course. Since Midwestern Community College is a small institution, these instructors could have been full-time faculty or adjunct instructors. However, this distinction does not impact the sample selection because it is the goal of both sets of instructors to enable their students to pass the on-level course. I used purposeful criterion sampling to select the six students that constituted the student sample. Purposeful sampling ensured that the students were taught by the two selected instructors, successful, made considerable progress, and had taken less than 16 hours within the last 20 years. I chose six students who were considered successful students by earning an A, B, or C in their on-level course. The instructors ended up having eight students that fit the criteria of the study, however only five students were willing to participate. In addition, these students made considerable progress from the teacher's perception. The selection criteria helped to achieve an information rich study.

Data Collection

I used three data collection methods. I observed teaching and learning behaviors in supplemental mathematics classrooms. I collected and review handouts and other documents. Finally, I conducted interviews with the five students and two instructors. The interview protocol is provided in Appendix A and B.

Data Analysis

Data analysis has been defined, as the process of "how we make sense of data" (Merriam, 1998). I followed Creswell's six-step process to analyze the data collected (Creswell, 2014). This process comprised of organizing the data, reviewing all data, coding data, developing themes from coding of data, demonstrating how themes are represented in the case study, and, finally, interpreting the findings. This six-step process enabled me to develop themes to answer the research questions.

I used Merriam's constant comparative method of data analysis to code my data, which included the data collected in the interviews, observations, and documents. Then I added codes to compare data. The data then was coded, allowing for the identification of the categories and themes that ultimately enabled me to answer my research questions.

Potential Significance of Study

Research

This study adds to the research in mathematics education in two ways. First, few studies have explored teaching strategies in supplemental mathematics. Second, the study examines students' perceptions of their progress as they journey toward becoming independent learners in mathematics. Findings from this study therefore identify successful teaching practices in supplemental mathematics courses at community college level that effectively support student learning.

Theory

Vygotsky's Zone of Proximal Development has been utilized extensively in K-12 education. This study extended its application to the community college level, specifically to, supplemental mathematics courses.

Practice

This study has helped to enrich and improve the practice of teaching supplemental mathematics at Midwestern Community College. Supplemental mathematics has proved to be successful in some cases at this community college. Though not generalizable, the findings of this study have helped to make teachers and administrators aware of practices such as educational scaffolding that successful teachers use in supplemental courses to effectively support student learning.

Definition of Terms

Corequisite mathematics. A supplemental mathematics course that must be taken at the same time as the on-level mathematics course. The supplemental course is designed as a support for the on-level course (Boatman et al., 2021).

Developmental courses. These courses, also known as remedial coursework, are designed to develop basic skills that include reading, writing, and mathematics for students who are need of improvement. This need is usually determined by ACT scores or high school transcripts (Ganga et al., 2018).

Gateway Course. Those courses that are foundational and are needed for all students to continue through their degree plan (Flanders, 2017).

On-level mathematics course. A course that a student enrolls in to earn college credit, usually 1000 level or higher (Squires et al., 2009).

Successful supplemental mathematics course. A course that prepares students to be successful in their on-level mathematics course. Success is a student's achievement of an A, B, or C grade in their on-level course (Kenney & Kallison, 1994).

Supplemental mathematics. A face-to-face course that is taken at the same time as the on-level course and is designed to provide additional instruction for on-level mathematics.

Recently, this course has also been offered as a O-Live course in which the students can Zoom supplement from any location at the same time as the supplement course. Students must be enrolled in an on-level mathematics course as well that can be taken any day of the week as long as it does not interfere with the supplement time (Kenney & Kallison, 1994; College Website, 2022).

Summary of the Study

This dissertation is divided into five chapters. Chapter 1 introduces the study. This introduction includes the problem statement, purpose statement, and research questions. In addition, I explain my epistemological perspective and theoretical framework. In Chapter 2, I provide a literature review of studies and other sources that represent the current state of academic knowledge related to my topic. I also present a thorough explanation of my study's theoretical framework. Next, in Chapter 3 I provide the methodology of the study. In Chapter 4 I give an in-depth description of the study's sample, observations, present findings thematically, and finally answer the research questions. Finally, in Chapter 5 I discuss the findings through Vygotsky's Zone of Proximal Development, explain implications, and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

Key topics discussed in this literature review include the following: (1) the background of community colleges; (2) developmental mathematics; (3) successful supplemental mathematics; (4) challenges to supplemental mathematics; and (5) zone of proximal development with educational scaffolding. The goal of this review is to provide an overview of the research related to: (1) the history and development of the community college; (2) math classes offered at community colleges; (3) the zone of proximal development with educational scaffolding; and (4) to link the theoretical framework with the purpose of this study.

Background of Community Colleges

Examining the history and development of community colleges will help explain the evolution of their current systems. Based on my study of the relevant literature, this section provides a review of the development of community colleges, their mission, composition, and the evolution of math classes at community colleges.

History of Community Colleges

Studies of the history of community colleges date their origin as far back as the 1800s (Mellow, 2000). In the 1800s, several small two-year private schools were

founded, including Monticello College and Susquehanna University, in 1835 and 1859 respectively (Geller, 2001). These two-year private schools acted as a foundational model for the development of future community colleges (Geller, 2001).

Even with the addition of the two-year colleges to the tertiary offering at the time, many groups remained excluded, primarily due to financial constraints (Drury, 2003) and the fact these colleges were designed for the professional class. In response to the ongoing exclusion, a call was sounded for the reform of higher education to make it more accessible for the working class. The United States Congress addressed the need for reform and passed the Morrill Act on July 2, 1862 (Geiger, 2017). This act encouraged the new western states to establish colleges by allowing the sale of federal land to be used for establishing such colleges or adding to existing state colleges. The focus of many of these new institutions was on agriculture and mechanics. The reform allowed access for many people who had previously been barred from higher education (1997), such as farmers and mechanics, as more schools added vocational curricula that served wider segments of the population. Thus, the Morrill Act created an explosion in the number of people receiving higher education (Carstensen, 1962).

Many academic texts categorize the history of community colleges into generations or distinct periods, such as *Renewing the American community college: Priorities and strategies for effective leadership* (Tillery & Deegan, 1985) and *A brief history of general education* (O'Banion, 2018). The authors identified four generations of community colleges. The first generation was from 1900 to 1930 (Tillery & Deegan, 1985). During this period, community college was largely seen as an extension of secondary school. While the Morrill Act resulted in the establishment of more four-year

universities, by the early 1900s only a small number of two-year schools had been added to the existing private colleges, Monticello and Susquehanna. In fact, at the start of this first period, in 1901, only nine two-year colleges existed. However, by about 1915, 75 two-year colleges had been established. This phenomenon coincided with many Americans moving to urban areas and into industry, increasing the demand for community colleges and the type of education they provided. World War I caused a decrease in enrollment at such colleges; however, after the war, the demand returned. By 1930, over 200 colleges had been established.

The second generation of community colleges evolved from 1930 to1950 (Tillery & Deegan, 1985). Community colleges experienced a boom at the start of the Great Depression because of a high rate of unemployment. The number of community colleges increased to more than 250. When World War II seemed imminent, enrollment once again started to lag. After WWII, community colleges enrollment increased once again. This rise in enrollment was largely due to the Serviceman's Readjustment Act of 1944, commonly known as the GI Bill. This allowed war veterans to attend college because their military service was regarded as payment. In addition, the Truman Commission seemed to have had a major impact on community colleges, and it was at this time that the term "community college" became the preferred term. President Truman established a commission that analyzed the educational system. This commission called for new community colleges and an increase in federal financial aid to students.

The third generation, between 1950 and 1970, became known as the "community college generation." The beginning of this period saw an increase in enrollment due to the Korean War. The Selective Service System was forced to give a deferment from

conscription to full-time students. By 1960, over 400 community colleges were in existence. During the 1960s, the number of community colleges increased to over 800. Several factors caused this growth. One factor was that the children of the soldiers returning home from WWII were now old enough to attend college. The children of soldiers could use GI bills or funds from other government programs for children of war veterans to pay for college. Another factor was the passing of two relevant pieces of legislation during the Vietnam War. The Higher Education Facilities Act and the Vocational Education Act of 1963 included specific outlines for the community college.

The fourth generation was from 1970 to 1985 and was named as the "comprehensive community college generation." As the Vietnam War drew to a close, returning soldiers were eager to use their GI Bill benefits. This demand contributed to a further rise in the number of community colleges. By the end of the 1970s, 100 additional community colleges had been founded. In 1981, Ronald Regan became president. He spoke highly of community colleges and the access to education that they provided. Nevertheless, public education funding was reduced during the early 1980s. Consequently, the number of community colleges showed little change.

Geller (2001) identified, two more generations. The fifth generation, which was not given a unique name, was from 1985 to 2000. This generation saw a decrease in community college enrollment due to a booming economy; Near full employment, negatively affected community college enrollment. In addition, state and federal funding continued to decrease during this period, which led to an increase in tuition for students.

Finally, the sixth generation dates from the post-2000s and is known as the "learning community college." The early 2000s was marked by war and economic

recession, which caused community college enrollment to thrive. In 2010, enrollment started to decline, and this trend has continued to the present day. Several factors have contributed to this decline, including the recession of 2008, less stringent admission requirements at four-year universities, a declining birthrate in the United States, and more recently, the COVID-19 pandemic. In the following section, findings in the literature relating to the mission and the evolution of the mission of community college will be discussed.

The Mission of Community Colleges

Initially, the primary mission of the community college was to prepare students for the workforce based on societal need (Ayers, 2002). This focus has since evolved into a two-fold mission: These colleges act as a preparation for students who intend either to transfer to a four-year university or to enter the workforce (Baime & Baun, 2016). The community college is now seen as a starting place for many students who hope to transfer to a four-year university. The following sections explore the two primary missions of community colleges.

Four-year transfers

Community colleges are playing a significant role in supporting student success in attainment of a bachelor's degree. Many students who start at a community college are unprepared for the challenges of a college-level education. They may display few of the qualities required or expected of a student embarking on a four-year degree course. However, when the time comes for many community college students to transfer to a four-year university, they are just as likely to obtain a bachelor's degree as their peers (Mullin, 2012). Of bachelor's degree recipients at four-year colleges, 28% started at a

community college, while 47% took at least one class at a community college campus (Mullin, 2012). Preparation for transfer to four-year universities is therefore an important part of the mission of community colleges.

Workforce

Preparing students for placement in the workforce was the original mission of the community college. Over time, workforce education has evolved in response to adult learners' needs (O'Banion, 2018). A careful consideration of the history of community colleges reveals the pattern of this evolution. The first major reform, the Morrill Act, was designed to support education in agriculture and mechanics and create a skilled workforce in those fields. The workforce mission has continued to evolve in response to reforms such as the Workforce Innovation and Opportunity Act of 2014, which helps job seekers to find educational opportunities that would help them meet employers' needs. The review of the literature leads us to conclude that workforce education will remain a primary mission for community colleges. However, workforce education will continue to evolve in response to the ever-changing composition of the community college and needs of society (O'Banion, 2018). The following section provides an overview of the composition of a community college.

Composition of a Community College

To understand how community colleges function, one should consider their composition. The three main elements of a community college are instructors, students, and enrollment and class size. These elements often have similarities and differences across community colleges such as faculty workload, instructor educational degree requirements, student body demographics, student financial need, student enrollment, and

programs instituted to help students succeed. Examining the literature on each one of these elements will allow the reader to gain a better understanding of a community college.

Instructors

Instructors at community colleges are typically female, white, and holders of a master's degree (Eagan, 2007). They can both be described as both a teacher and a practitioner (Richardson et al., 1972). To teach at an Oklahoma community college, instructors must have earned 18 hours in graduate courses in their subject area. For example, if an instructor wanted to teach mathematics, they would need to have earned 18 hours in graduate mathematics and it be reflected on the instructor's college transcript. Some but not all community colleges require a master's degree. The workload of community college instructors varies. Some instructors would be responsible for teaching 6 to 24 hours of college courses per semester. Division chairs normally teach 6 to 9 hours of classes, while full-time faculty must teach 12 hours or more per semester.

Students

The demographics of the student body at community colleges vary based on geographical area. According to data collected by the U.S. Census Bureau, the general population of students is made up of 45% White, 26% Hispanic, and 13% Black (Armstrong et al., 2021). The average age of a community college student is 28 (Armstrong et al., 2021). However, some student characteristics are consistent across community colleges. Most community college students do not test into on-level courses and need remedial coursework. At some colleges, the percentage of students that need remedial education is 64% (Hawley & Harris, 2005).

Economic considerations and family commitments often impact community college students, many of whom help support their families by working part-time (Craig & Ward, 2008). Community colleges offer them the opportunity to get an education while they continue to help their families financially. A further similarity between community college students is they generally lack a thorough understanding of the postsecondary-system (McKinney & Novak, 2013). They have no knowledge of the process involved applying for scholarships or grants, or completing the Free Application for Federal Student Aid (FAFSA). Community colleges often provide information and support to students who intend to embark on these processes.

Enrollment and Class Size

In recent years, enrollment at community colleges has been declining (Juszkiewicz, 2020). Student bodies at most community colleges are much smaller than those at four-year institutions. Enrollment figures often differ between colleges in accordance with geography and workforce need. In Urban areas community colleges often have higher enrollment because those colleges service a larger population, while those in rural areas have smaller populations because there is a smaller population. There are also might be a difference in enrollment due to the workforce need. Community colleges that offer a program for a career that is needed in society will likely have higher enrollment.

The class sizes are also traditionally smaller at community colleges. Most community colleges attempt to cap class enrollment at 25 students. In fact, class size at a community college is significantly smaller than the equivalent class offered at a four-year university (Boggs, 2011). Small classes create greater opportunity for one-on-one

interaction in the classroom, allowing instructors to connect better with their students (Townsend & Wilson, 2006). The classroom size and environment often increase part-time four-year university student enrollment. These students usually enroll in mathematics or other gateway courses at the community college instead of their four-year university (Mullin, 2012). Many community colleges also refine their enrollment in specific math classes through a program called Math Pathways. The following section, will examine the literature on Math Pathways and the program's effect on community colleges.

Math Pathways

In examining how community colleges use Math Pathways it is important to understand how students were first placed into mathematics classes. In many cases, students were by default put into Science, Technology, Engineering, and Mathematics (STEM) track courses such as College Algebra. The idea was to help prepare students for Calculus and other areas of advanced mathematics. However, only about 10 to 15% of students ultimately enrolled in Calculus (Ganga et al., 2018). Student's broader program of study was not considered when placements in a mathematics course were being made. Programs of study could range from engineering to education, but all students would be placed in the same beginning mathematics class. At community colleges, the success rate of students in College Algebra was about 50%. Mathematics was acting as a barrier to many students at community colleges, preventing them from graduating or transferring to a four-year university.

In the Midwest, a prominent version of Math Pathways was developed by the Dana Center at the University of Texas at Austin (Ganga et al., 2018). The Dana Center

developed three pathways for students: statistics, quantitative reasoning, and a path to calculus. They then applied this model in 2013-2014 at nine colleges in Texas. Those students who were assigned to a Math Pathways became 50% more likely to pass college-level mathematics after only three semesters of implementation in Texas (Ganga et al., 2018). The Dana Center model has since spread to other states including Arkansas and Oklahoma. In Fall 2018, all 22 public two-year schools and 11 four-year colleges had implemented Math Pathways in Arkansas. Likewise, in Fall 2018, 12 two-year and 15 four-year Oklahoma schools implemented Math Pathways. In Oklahoma Math Pathways, has been shown to increase student success rates and address the large amount of developmental mathematics students at a community college (Baker, 2019). The following section will provide a history of developmental mathematics at a community college by examining the relevant literature.

History of Developmental Mathematics Courses at Community Colleges

In the literature, students who are enrolled in developmental mathematics classes are those who are not ready for college-level courses (Silverman & Seidman, 2011). Students who need developmental courses often choose community colleges. In the 1990s, more than 60% of students at these colleges were enrolled in developmental courses (Zeidenberg et al., 2007).

Community Colleges and universities originally taught developmental mathematics in the following sequence: arithmetic, elementary algebra, and intermediate algebra (Ariovich & Walker, 2014). Classes in each of these areas lasted one semester. After completing the three-semester sequence, the student would take the college-level mathematics course. The amount of time spent in developmental mathematics courses

impacted student retention rates, which would often lead to lower retention rates in developmental courses and subsequent on-level courses if a student was able to achieve enrollment (Ngo & Kosiewicz, 2017). Many students began to leave college as a result of their inability to successfully pass through the mathematical sequence. A lot of community colleges and universities began to redesign their mathematics programs (Ariovich & Walker, 2014). At present, many community colleges are now offering a corequisite developmental course. Students take their developmental course, often called a supplement, and their on-level mathematics course simultaneously (Vandal, 2014). The following section provides an exploration of the history of how sequenced developmental mathematics became corequisite supplemental mathematics at community colleges, the differing models of supplemental instruction and supplemental mathematics utilization in Oklahoma.

Developmental Mathematics

Boylan and Bonham (2007) accurately described developmental education when they said it was designed to help students be successful in reaching their collegiate goals. Developmental coursework was often required for "high risk" courses such as mathematics. High-risk courses are defined as those that had an increased failure and dropout rate and included mathematics courses. While mathematics was regarded as a high-risk course, it was also a gateway to graduation or four-year transfer (Ngo & Kosiewicz, 2017).

Developmental mathematics has long been the topic of research. Most of the studies focused on the period when courses were offered in the sequence mentioned above, and students often had to take three to four mathematics courses just to earn credit

for one on-level mathematics course. Findings from previous studies concluded that developmental mathematics in sequence did not work. In fact, some studies reported that up to 81.5% of students who tried to complete the sequence did not finish their degree (Bahr, 2008). Thus, there was a need for a corequisite course known as supplemental instruction. The following section provides a history of supplemental mathematics.

History of Supplemental Mathematics

Supplemental mathematics programs were designed to help struggling students (Hunt et al., 2016). Phelps and Evans stated that "Supplemental Instruction (SI) quickly gained recognition as an academic support program used to aid student performance, retention, and academic success" (2006, p. 23). Dr. Martin was a pioneer in the field of SI. In the early 1970s, the University of Missouri in Kansas City had retention problems from undergraduates to students enrolled in professional schools. To address the retention problem, the university appointed then doctoral student Deanna Martin. Her primary mission was to solve the problem of student attrition. In her attempt to increase retention she identified many "gateway courses" as inhibitors of student advancement. Gateway courses are defined as those foundational courses that are needed for all students to pass to continue through their degree plan (Flanders, 2017). A large proportion of students in gateway courses were making grades of C or below or withdrawing altogether and earning a W. Mathematics was identified as a gateway course. Mathematics courses often became an obstacle for students on their journey to graduation. Dr. Martin developed a supplemental instruction model to increase retention at the university.

Dr. Martin's model of supplemental instruction courses was the framework of how supplemental classes are taught at many community colleges. There are some

community colleges that use Dr. Martin's exact model of supplemental instruction (Zaritsky & Toce, 2006). At University of Kansas City in Missouri the supplemental instruction that was offered, throughout the semester, student-led, and peer-assisted (Martin & Arendale, 1992). The students used this supplemental instruction as an extension of their on-level courses. The faculty involvement in supplemental instruction was voluntary with varying level of participation (Martin & Arendale, 1992). However, there are other community colleges who use a modified version of Dr. Martin's model. The supplemental classes are still an extension of the on-level class, but instead they are compulsory (Jenkins et al., 2018) and a faculty or adjunct leads the class, but there is still quite a lot of peer-peer learning. The latter of the two versions would provide a basis for many community college supplemental mathematics programs. The following section explores how supplemental mathematics is utilized at community colleges.

Supplemental Mathematics

Colleges reacted to the many challenges that community college students were facing by, introducing learning assistance to their struggling students (Logue, 2018). Many colleges established tutoring centers for mathematics on their campuses. In recent times, colleges have also been offering a limited number of online tutoring hours. However, many students did not utilize a tutoring center or online tutoring until after they had failed the course. Colleges therefore needed to change in the way in which they taught developmental mathematics (Logue, 2018).

In Oklahoma, corequisite remediation was identified as a priority. This was largely due to the high rate of failure in gateway courses such as mathematics that used a sequential model. In 2017, the state reported that 90% of its colleges and universities

offered corequisite remediation (Caddell, 2018). Students who need remediation are now placed in a supplemental class where they receive supplemental instruction at the same time as their on-level mathematics course.

Supplemental instruction's primary goal was to help students pass their on-level courses by teaching students to become independent learners (Atkins & Beggs, 2017). The course does this by facilitating learning between the students and the supplemental instruction teacher. The supplemental teacher is the bridge between the actual class and the supplemental class. In the supplemental class, the supplemental teacher goes over course content, material, and effective learning strategies. This allows students to gain the skills needed to understand concepts and develop questions over the material. By doing so, students are then able to take ownership of their own learning. Community colleges saw more successful students in a corequisite math classes than sequential math classes (Atkins & Beggs, 2017). The following section will explore some of the successful corequisite programs at community colleges, why they were successful, and what we can learn from their success.

Successful Corequisite Mathematics Programs

Many successful supplemental mathematics programs are in operation at community colleges. Such programs are considered to be successful if they produce a large number of successful students, meaning a student who passes their on-level course with an A, B, or C. However, a student who is successful in their on-level mathematics has acquired a great deal more than simply earning a passing grade. They learn study skills, develop advocacy skills, and make connections with fellow students and the instructor (Martin & Arendale, 1992).

The literature referenced many successful programs that helped community college students succeed. Three of these programs exemplified supplemental instruction's potential for success. These successful programs were at LaGuardia Community College, Cleveland State Community College, and Ivy Tech Community College. In each of these cases supplemental instruction took the form of a corequisite mathematics program at the community college level to help students prepare for their on-level course (Logue, 2018). This corequisite model helped to increase success among students at these community colleges. Furthermore, it is important to examine all the factors that made these community colleges' corequisite mathematics program successful. The reasons for success included techniques used in the classroom: classroom environment; student, faculty, and administrator willingness to adopt and support corequisite mathematics; Math Pathways and its' ability to put students on the correct mathematical pathway aligned with their major; enrollment and completion of mathematics in the first year of college; and the multiple supports that exist within each college to help with student success (Zaritsky & Toce, 2006; Jenkins et al., 2018; Royer & Baker, 2018).

The aforementioned programs can provide a foundation on what a successful supplemental mathematics corequisite should be modeled. These programs are important because they provide a framework of how successful supplemental classes are structured at a community college. In addition, these programs are important because the community colleges all had previously utilized sequential developmental mathematics, meaning students could have to pass up to three semesters of developmental classwork before being allowed to enroll in on-level mathematics, which is the same method Oklahoma community colleges had utilized prior to the switch to corequisite education.

Finally, these programs are important because each has instituted a successful corequisite mathematics program at the community college level to help students be prepared for their on-level course (Logue, 2018).

Successful Programs

LaGuardia Community College

LaGuardia Community College is located in Queens, New York. This college followed the same type of supplemental instruction as Dr. Martin had first developed at the University of Missouri Kansas City in that the SI sessions were not compulsory, but instead were encouraged by faculty for all students. The program was led by students, who had successfully completed the on-level course with an A or B. In the SI sessions, the leaders encouraged collaboration, cooperation, and student questioning to facilitate asking questions in SI sessions and on-level classes (Zaritsky & Toce, 2006). The SI leaders used educational scaffolding such as modeling and questioning to help students become independent learners (Zaritsky & Toce, 2006). The students became much more successful in on-level courses as a result of the techniques used in the SI sessions. LaGuardia Community College found the factor that made the program the most successful was the continued refinement of the SI sessions and the support from faculty and administration (Zaritsky & Toce, 2006).

Cleveland State Community College

Cleveland State Community College is located in Bradley County, Tennessee. A tremendous number of students entered Cleveland State Community College with a high need for developmental mathematics education (Jenkins et al., 2008). Many of these students dropped out due to the number of mathematics courses they needed to achieve

one on-level mathematics course. In Tennessee, the state board of regents started a corequisite remediation system-wide in 2015 with a complete redesign of their developmental college courses. Their goal was to get all colleges to use corequisite remediation by 2022. At the same time, they instituted Math Pathways, which helped students get placed into the correct mathematics classrooms. Cleveland State started with corequisite remediation in mathematics in 2006, ahead of the initiative by the board of regents (Jenkins et al., 2018).

In 2006, Cleveland State first provided modularized support for only mathematics. This type of support is tailored to an individual student's needs. The students still enroll in an on-level course that is identical to any of their peers who do not have the support, but also get this extra course known as a supplemental corequisite. The learning support course does not contribute to the grade earned in the on-level course. This type of learning was then expanded to many more courses in 2016 (Ran & Lin, 2019). Since then the preliminary results in instituting a corequisite course at Cleveland State have been good.

Cleveland State Community College found that their program was successful for four primary reasons (Jenkins et al, 2018). First, Math Pathways allowed the student to be placed into the correct mathematics course, which helped align the goals or career aspirations of a student to their mathematics course. Secondly, the college also developed a better admissions process to facilitate career and academic exploration before a student was put on a mathematical pathway. Third, the college advisor is then placing students into a mathematical course within the first year and enrolling those students who need additional help in a corequisite course. The corequisite course used educational

scaffolding techniques to transition students from a dependent to independent learner. Finally, there is tremendous outreach among advisors to make sure these students are succeeding in these corequisite courses. The advisors routinely check on and meet with these students. As a result, the student success rate for passing on-level math has increased. Graduation rates and transfer rates to four-year universities have also increased since corequisite remediation was implemented (Ran & Lin, 2019).

Ivy Tech Community College

Ivy Tech Community College is located in Marion County, Indiana and still relatively new as a community college. The transition from a private university to a community college was not a simple one for Ivy Tech Community College. Furthermore, the college immediately noticed that many students failed to enroll in mathematics and those that did, had participated in developmental courses and did not usually pass their mathematics course. They sought to make a change to increase their student success rates.

In 2011, they hired Saundra King from Chattanooga State Community College in Tennessee, which had just gone through a renovation of their mathematics program to increase success among students (Royer & Baker, 2018). Ivy Tech Community College's hope was to bring that same innovation to their mathematics program. Ivy Tech Community College instituted a new program in 2014 that relied on the new Math Pathways program and the corequisite mathematics remediation model. This model began to show immediate results in students' success in completing their on-level math course with a 15% jump from the previous prerequisite mode (Royer & Baker, 2018).

They found the program to be successful for three primary reasons (Royer & Baker, 2018). The corequisite model allowed students to access on-level classes faster, unlike the previous sequential model. Secondly, the class was now done as a course that was completed in the first year instead of a five-semester sequence. Finally, the correct math pathway allowed students to be in a math class that resembled their field of study. The following section will examine some of the classroom factors that increased success among students in supplemental mathematics programs.

Additional Factors that Increased Success in Supplemental Mathematics

In addition to looking at successful programs, it is important to examine other factors that make these programs successful. Classroom environment in corequisite remediation classes often helps with student success rate because a good classroom environment can foster collaboration and cooperation (Vorozhbit, 2012). The increased collaboration and cooperation is a fundamental part of the successful corequisite programs (Kashyap & Mathew, 2017). This improvement helps those students become more successful in their on-level mathematics courses.

Improvements in the Classroom Environment

The literature shows that the corequisite classroom learning and teaching environment was improved and led to increase in student success (Vorozhbit, 2012). Instructors reported the strengthening of cooperation and collaboration, enabling students to take the risk of asking and answering questions without fearing that they would give the wrong answer. These skills and techniques have been found to be vital in aiding academic development and knowledge acquisition (Skoglund et al., 2018). The following sections will provide an overview of cooperation and collaboration.

Cooperation

Cooperation among students increases the students' motivation level for the class. The literature tells us that students in mathematics can be shut off and lack the motivation to learn. The students in supplemental courses taught as a corequisite tend to have a higher cooperation rate among peers and instructors (Kashyap & Mathew, 2017). Cooperation leads to increased motivation (Young, 2005) where students are engaged and proactive with their learning. The students are more successful because they are willing to cooperate with their instructors and peers, instead of relying solely on themselves to understand the material.

Collaboration

Collaboration is the students working together to solve a problem in the classroom. "Collaboration can have powerful effects on student-learning, particularly for low-achieving students" (Lai, 2011, p. 2). In many traditional mathematics classrooms students are seated in rows and do not do much collaboration with other students (Lai, 2011). However, in supplemental classrooms students work with their peers. The students use collaboration to become independent learners and achieve success in their on-level classes (Skoglund et al., 2018). The following section provides a summary of the many factors that enhance and promote successful mathematics programs at a community college.

Summary of the Success Factors

Successful corequisite models share several characteristics that community colleges can use to implement successful programs. The first, as identified in the literature is that college administrators, faculty, staff, and students worked together to support a successful corequisite program. Next, these schools are also implementing a

rather new program called Math Pathways, which helps to place students in the appropriate math course based on their majors. Finally, courses were successful because the classroom environment was adapted to encourage collaboration, cooperation, and using scaffolding techniques to transition students from dependent to independent learners. All these factors enabled students to successfully complete both their supplemental and on-level mathematics course. However, there are challenges to successful corequisite programs. The following section explores some of those challenges.

Challenges to Supplemental Mathematics

Despite the many successes of corequisite mathematics programs, some challenges remain. Critics point to the large number of students who are still failing both the supplemental course and the on-level course, even in programs that are deemed successful leading to increased costs among students and colleges (Bowman, 2021; Belfield et al., 2016). In the aforementioned colleges of Cleveland State Community College and Ivy Tech Community College, the colleges observed huge increases in student achievement, more than doubling their success rates, however, there were still a fraction of students that did not pass (Ran & Lin, 2019; Royer & Baker, 2018). Finally, some critics say corequisite mathematics is not effective at all (Bowman, 2021).

Costs

Based on a study by Jaggars & Stacey (2014), the cost of providing remediation to community college students has been estimated at seven billion dollars per year. Compounding that high cost is the fact that only about 28% of community college students who take developmental courses earn a degree in eight years (Jaggars &Stacey,

2014). Therefore, many state governments, educators, community members, and others are left wondering whether these costs are justified.

Redesigning mathematics curricula to institute corequisite mathematics is also a costly exercise. These costs stem from the need to train faculty and staff, plan curricula, and outline new courses. Students, who often do not receive credit for their on-level course, also face cost implications. Students do not pass the course on their first try often pay for a course two or three times. High levels of debt have a long-term negative effect on students and may hurt community college enrollment (Levin & Calcagno, 2008). Stakeholders may see students inability to succeed and accruing student debt as a reason not to enroll in the college.

Criticism of Corequisite Mathematics

At least one study has claimed that corequisite mathematics is not effective in increasing community colleges' graduation rates or transfers of students pursuing a bachelor's at a four-year college (Bowman, 2021). A study, by Bowman (2021), examined Reinforced Instruction for Student Excellence (RISE), a program that was introduced in North Carolina in 2019 as a corequisite mathematical model. Bowman's study examined over 2,500 students from three community colleges in North Carolina. The researcher concluded that RISE had a negative impact on the successful completion of math courses and credit accumulation for full-time students and had no impact on part-time students. Thus, Bowman found that RISE did not support students (Bowman, 2021). The following section summarizes the challenges of corequisite mathematical models.

Summary of Challenges

Students who wish to be successful in corequisite mathematical models face many challenges, as reflected in the high number of students who are still not passing their on-level mathematics course. Challenges include the growing cost of remedial coursework at community colleges and the fact enrolling corequisite programs do not necessarily result in success (Jaggars &Stacey, 2014). These challenges need to be fully addressed to ensure successful students. Despite, the challenges of supplemental mathematics as a corequisite there is still a need for this model. The following section explores that need.

The Need for Supplemental Mathematics as a Corequisite

Many scholars have identified the need for supplemental mathematics as a corequisite for students who enter college on the developmental track (Zaritsky & Toce, 2006; Jenkins et al., 2018; Royer & Baker, 2018). Math Pathways supports this success by directing students to mathematics courses that align with the subjects they intend to major in (Ganga et al., 2018). The combination of corequisite mathematics and Math Pathways leads to a better classroom environment by increasing collaboration and cooperation (Young, 2005). Therefore, having supplemental mathematics as a corequisite is a crucial component.

Supplemental mathematics as a corequisite does not automatically ensure the successful preparation of students for their on-level mathematics course. Instead, success depends on a combination of factors that include corequisite mathematics, Math Pathways, and an interactive and collaborative classroom environment (Ganga et al., 2018). These factors help students become prepared for their on-level mathematics course. Thus, creating a higher success rate in on-level mathematics. There are still gaps,

though in examining the literature on supplemental mathematics. The following section examines those gaps.

Gaps in the Literature of Developmental Mathematics

The gap in the literature on this subject is significant. The main shortcoming is that previous studies were primarily quantitative (Dawson et al., 2014). Quantitative studies can only test for and compare measurable variables, such as final grades, student ability to earn an A, B, or C in on-level courses, the grade that are often considered "passing" in most majors compared to a D, F, or W (Vorozhbit, 2012). They also examine consequences like retention rates among students enrolled in supplemental instruction (Skoglund et al., 2018). These studies use statistical analyses like t-scores, confidence intervals, and ANOVA, which are all trademarks of a quantitative study. However, in a qualitative study there is a deeper understanding of the situation.

Furthermore, the literature considered past models of supplemental mathematics programs. Specifically, these models required students to pass prerequisites before they were allowed to do on-level coursework. However, in current mathematics education models the students enroll in supplemental mathematics as a corequisite. The corequisite model in developmental mathematics education is relatively new to the literature, and there has not been the same amount of extensive research either quantitative or qualitative.

A further shortcoming of the existing literature is the way in which supplemental instruction was defined, namely sessions presented for the duration of the semester by a leader, who could have been a fellow student appointed and remunerated by the university. In the literature, many studies have defined supplemental instruction as this

type of model laid out by Dr. Martin (Martin & Arendale, 1992). Few studies had as their subject students who enrolled in supplemental instruction as a corequisite remediation course taught by a full-time faculty member or adjunct instructor. There have also been few studies investigating programs where enrollment in supplemental instruction is compulsory for students and supplemental courses are included on the students' transcripts and factored into a student's GPA. This is important because now community colleges are instituting consequences for not attending and passing supplemental instruction.

Finally, the majority of previous studies focused on four-year universities. Few studies examined community colleges where most of the students are considered remedial (Skoglund et al., 2018). Studies that explore the impact of supplemental instruction in this unique environment are necessary. The following section examines this study's theoretical framework, Vygotsky's Zone of Proximal Development with educational scaffolding, which provides a lens on how community colleges prepare students to be successful in this unique environment.

Conceptual Framework

The conceptual framework for this study is Vygotsky's Zone of Proximal Development with educational scaffolding, as mentioned in Chapter 1. Cazden noted that the interaction and communication between teachers and students that underlies the theory of scaffolding, as proposed by Wood, Bruner, and Ross resembled Vygotsky's Zone of Proximal Development (Xi & Lantolf, 2021). While, Vygotsky did not refer to scaffolding as such when describing the Zone of Proximal Development, many educational scholars now consider scaffolding as a metaphor that was present in

Vygotsky's work. Vygotsky was a Soviet psychologist known for his work with children. He produced a great volume of work but his ideas remained largely unknown in the West until the 1980s and the movement of social constructivism. Some controversy surrounds Vygotsky's notion of the Zone of Proximal Development (Xi & Lantolf, 2021), specifically around the length of each stage. This controversy stems primarily from the poor translation of Russian to English (Xi & Lantolf, 2021). Nevertheless, Vygotsky's Zone of Proximal Development remains an influential theory used in many studies. The following section examines similar research that used the Zone of Proximal Development as a theoretical framework.

Similar Research

Similar to this study, some studies have considered the Zone of Proximal Development with educational scaffolding. However, most of these studies focused on students in primary or secondary school. For example, one study, that takes place in Indonesia, describes a mathematics teacher that separated fourth graders into two groups based on IQ and then used the Zone of Proximal Development with educational scaffolding to help those students who were in the lower IQ range (Kusmaryono & Kusumaningsih, 2021). Another study was conducted in New Zealand with disadvantaged primary school students. Many of these students were dependent learners. The educators used educational scaffolding as a tool to transition students from dependent learners to independent learners. In this study, teachers followed scripts to teach students. The result was that mathematical educators should not just focus on mathematical knowledge, but also focus on how mathematics is communicated and

collaborated in the classroom. Furthermore, the teacher must address their own teaching methods and the way students learn (Hunter, 2012).

Recently, there have been an increase in researchers that utilized Vygotsky's Zone of Proximal Development to explain findings at the college level. A study used formative assessments in an introductory calculus class to see where students were positioned in the Zone of Proximal Development. Then the study used the Zone of Proximal Development with educational scaffolding as a theoretical framework to examine students and how they became more knowledgeable in the subject matter (Dibbs, 2014). A phenomenological study of supplemental instruction in a Florida community college also used the Zone of Proximal Development with educational scaffolding (Phelps, 2005). The study used the theoretical framework in the supplemental instruction classes to explore student success. The study found educational scaffolding used in supplement classes helped increase student achievement (Phelps, 2005). The following section explores the Zone of Proximal Development with educational scaffolding and why it is well suited for this study.

The Zone of Proximal Development with Educational Scaffolding

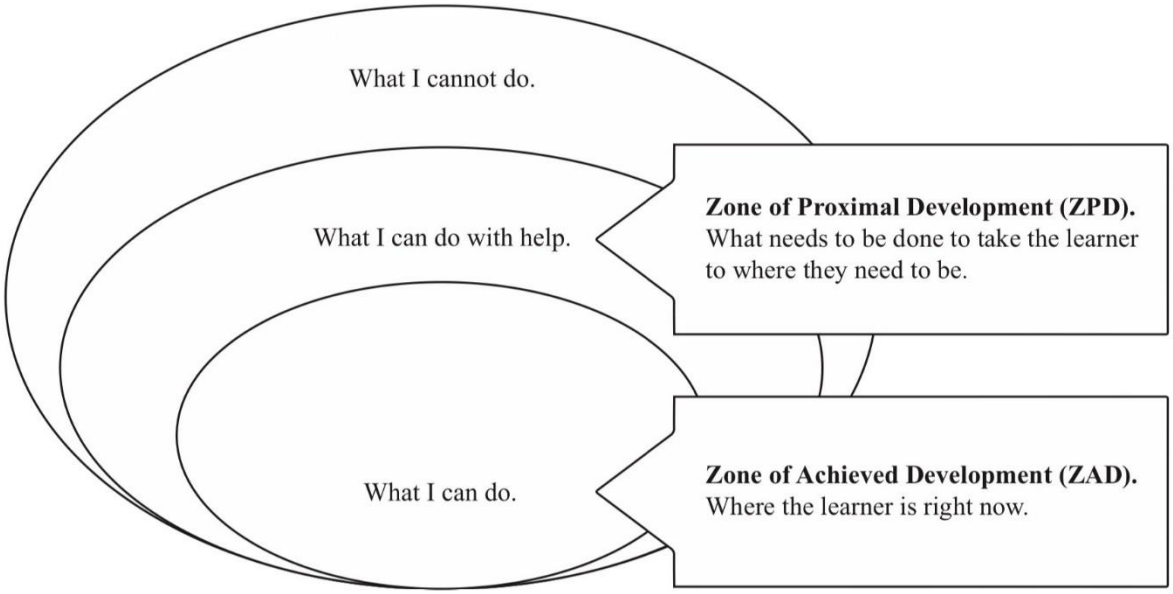
Vygotsky defined the Zone of Proximal Development (ZPD) as "the distance between the actual development level as determined through problem solving and the level of potential development as determined through problem solving under guidance or in collaboration with more capable peers" (Vygotsky & Cole, 1978, p. 86). This process can be further described as what the less knowledgeable person in the ZPD can accomplish with the help of a more knowledgeable person and form the groundwork for the next developmental phase. In the next developmental phase, the learner continues

learning with mediation from other learners or teachers through interactions. The instructor continues to develop this knowledge until the learner can be independent and supports are withdrawn (Eun, 2019). The instructor's job is to provide stimulation and reassurance to the students and help them continue their growth to higher levels of development. The educator does this through scaffolding methods that are formed to help the student. These support methods are then systematically withdrawn in response to the student's progress (Sanders & Welk, 2005).

The ZPD takes place over three stages. In the first stage, students are assisted by teachers, peers, tutors, or other knowledgeable people. The students often cannot master any of the material without this assistance. In this stage, the instructor tailors assistance to the students' needs and learning goals. The instructor must therefore provide appropriate assistance to help the student progress through the ZPD. In the second stage, a student's performance is directed by the student, and they take more responsibility for their own learning. The student may be able to do some work on their own, but will also need assistance from peers or instructors. The students' performance continues to develop, and their knowledge is refined. At this level, students begin motivating themselves to become independent learners. In the final stage, assistance from others is no longer needed. This is sometimes called the Zone of Achieved Development (Khan, 2017). The student has emerged from the ZPD. They have internalized the concepts and are able to perform the tasks. The student no longer needs an expert to help them perform their task. The stages are modeled in Figure 2.1.

Figure 2.1

Vygotsky's Model of the Zone of Proximal Development

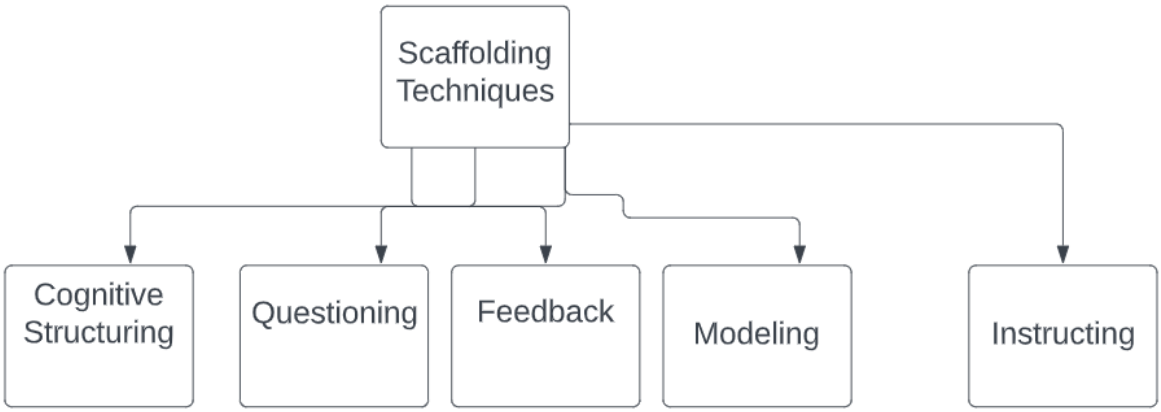


Note. Adapted from Khan (2017). *Mathematics proficiency of primary school students in Trinidad and Tobago*. Teachers College, Columbia University.

The instructor uses educational scaffolding techniques to help students operate through the three stages of the ZPD. Educational scaffolding has long been seen as a teaching performance in a one-way communication. However, the ZPD primarily emphasizes teacher-learner collaboration and negotiation (Verenikina, 2003). Thus, the combination of the ZPD with educational scaffolding creates that dialogue that uses previously established teaching techniques to help students become independent learners. There are many educational scaffolding techniques, including modeling, feedback, instructing, questioning, and cognitive structuring (Sanders & Welk, 2005). These techniques are shown in Figure 2.2.

Figure 2.2

Scaffolding Techniques



Note. These are scaffolding techniques that can be used to navigate through the Zone of Proximal Development.

Modeling

The classroom environment is very important to the success of students (MacAulay, 1990). Students need to feel comfortable asking questions in class. For such an environment to flourish, the instructor needs to create an atmosphere of mutual respect. To continue to develop, students need to view their teacher as a positive source of information. For example, a teacher may model how to use Khan Academy to show students where to get help if they do not have access to an instructor. Similarly, the instructor may show the student how to ask a question on their homework using the homework web page. Furthermore, the instructor may also demonstrate problems and examples to students to help with conceptual understanding. This modeling helps create respect between student and the instructor, thus leading to better student understanding.

Feedback

Classroom feedback is a powerful scaffolding technique (Hattie & Timperley, 2007). The feedback process is based on the information that instructors give students on what is correct and what needs to be improved. Two primary types of feedback can be used in the classroom. The instructor can walk around and examines student work, giving immediate feedback when the work is wrong or encouraging the student when their work is right. The instructor can also provide feedback on homework and assessments. These types of feedback have been shown to reduce math anxiety in higher education (Núñez-Peña et al., 2015). The other type of feedback is from peers. Peers frequently work together through collaborative exercises in mathematics. The students can use each other to measure their own progress and identify whether they need further instruction on topics.

Instruction

The primary type of instruction used in educational scaffolding is differentiated instruction. This type of instruction provides a wide range of instructional options to a diverse group of students. Differentiated instruction allows students to understand new material in different ways (Hall, 2002). The instructor makes the content either more or less challenging based on a student's level. After being introduced to new content by the teacher, students can work in groups to test their understanding of the material. Finally, to show mastery, students can present the material in non-traditional ways such as a group presentation or if working independently on homework they can send a text message. The instructor is making it possible for the student to achieve personal mastery by gradually withdrawing the instructor's support. Providing students with study plans in preparation for exams and helping them develop a strategy for success are also forms of instruction.

Questioning

The role of questioning is to prompt interaction between instructors, students, and peers (Xun & Land, 2004). Questioning also prompts reflection and construction of knowledge in the classroom (Engin, 2013). Instructors can use questioning in a variety of ways to support scaffolding. Instructors may ask easier questions that have one-word answers, progressing to questions that require students to interpret concepts. For example, a student may first be asked to identify the slope and subsequently to interpret what the slope means.

Cognitive Structuring

Cognitive structures are a psychological process that students use to understand information and are an important part of memorizing and understanding information. There are three classes of cognitive structures. The first cognitive structure is memorization that denotes a student's ability to memorize and classify information. The second cognitive structure is symbolic that shows how subjects like mathematics are represented in a student's mental process. The final cognitive structure is logical reasoning that help explain things like problem solving (Dunphy & Dunphy, 2003). The instructor can continually refer to concepts taught in previous classes and examine how students use and apply these concepts. The instructor can use this knowledge to see how much the student knows and where they are in the ZPD.

Well-Suited for this Study

The ZPD with educational scaffolding is well-suited for this study because it provides a framework for how instructors and classes prepare students for their on-level mathematics courses. The instructors use scaffolding techniques to transition students

from dependent to independent mathematical learners while navigating through the ZPD. The ZPD with educational scaffolding gives a framework of how the transition from a dependent to an independent learner is accomplished. The instructors use educational scaffolding techniques such as modeling, feedback, instructing, questioning, and cognitive structuring to move from stage 1 to stage 3 of the Zone of Proximal Development. The combination of these educational theories shows how learners are being prepared for their on-level courses in corequisite models.

Summary

The community college has a long, complex history. Global events such as WWII and COVID-19 changed the educational goals of community colleges. Students often arrive at community colleges woefully underprepared creating need for developmental coursework. Developmental mathematics have among the highest enrollment figures at community colleges. Mathematics is seen as a gateway in community college. The teaching of developmental courses has changed quite a bit to better retain students in college.

Many colleges have introduced the corequisite supplemental instruction model. This allows for students to take supplemental mathematics as a corequisite at the same time as their on-level course, receive additional instruction, and work collaboratively with other students. Students who have received supplemental instruction as a corequisite tended to be successful in passing their on-level course. However, supplemental students continue to face challenges, which impacts on the success rates of support courses. Challenges include the rising cost of remedial coursework and the fact that for some students the courses are ineffective. Finally, the Zone of Proximal Development with

educational scaffolding can be used to identify a student's level of knowledge so that appropriate support can be provided. Such support would help students to journey from being a dependent learner to becoming independent. The following chapter presents the methods and procedures for this study.

CHAPTER III

METHODOLOGY

Mathematics education at community colleges involves many complex issues that are worthy of examination. Previous researchers have opted for quantitative analysis to study the efficacy of mathematics teaching (Cullinane & Treisman, 2010); however, quantitative analysis has certain limitations that preclude a more in-depth understanding of participant perspectives regarding their experiences in mathematics courses. Miller and Crabtree (1994) described qualitative research as a way to understand phenomena that are occurring. Hancock et al. (2001) stated that qualitative methods aim "to help us understand the social world in which we live and why things are the way they are" (p. 7). Qualitative design, in this study, allows for an in-depth understanding of the factors that contribute (or not) to student success in mathematics education at this selected community college.

It was with this desire to gain an understanding of supplemental mathematics that I approached my study on how successful instructors prepared their students for on-level mathematics. I hope to shed light on the techniques these instructors use to prepare students and the students' viewpoints of supplemental mathematics. This chapter outlines the methodology I used in this journey.

Problem Statement

Since the opportunity to attend college has become a reality for a more diverse student population, students often enter community colleges with a wide range of skills and backgrounds (Baime & Baun, 2016). Many entrants lack the skills or level of understandings required for success in college courses. Specifically, many students lack college-level mathematical skills because of problems associated with poorly funded education in high-poverty areas and teacher quality in underfunded schools (Peske & Haycock, 2006). Students from underfunded high schools are often underprepared for college-level math because they often did not receive the support that they needed in their math courses (Peske & Haycock, 2006).

Mathematics and Freshman Composition are the two courses that pose significant challenges to students entering college (Lagerlof & Seltzer, 2012). These courses are required and are fundamental for success throughout college. To support student success in these courses, many community colleges have established remedial courses, referred to in this study as "supplemental courses" to support student learning. The typical design of college level courses is for students to receive instruction during class meetings, but they are responsible for their individual progress and performance on class assignments and exams, with limited additional support from the instructor. However, supplemental courses provide the support that students need as they learn the material and move from dependence on the instructor to independent learning. These courses are provided in parallel with the college-level course, and emphasis is placed on foundational knowledge.

Despite such consistent support through supplemental courses, some students experience success in college classes (Altomare & Moreno-Gongora, 2018) and while

others do not (Phelps & Evans, 2006). It is important to understand why some students are successful and others not because a support program that does not meet the needs of the underprepared student could prevent them from progressing and, ultimately, from completing college.

Course design is a possible explanation for the success of some students and the failure of others. Specifically, if courses are scaffolded to transfer responsibility for learning to students after they have developed the required skills, rather than transferring responsibility too early in the process, students would have the opportunity to acquire the skills needed for success (Verenikina, 2003). Vygotsky's Model of the Zone of Proximal Development provides a framework to understand how scaffolding supports student success in the classroom as they move from dependence on help from the instructor to more independent work.

Purpose of the Study

The purpose of this study was to explore, through the lens of Vygotsky's Model of the Zone of Proximal Development, how successful instructors of supplemental mathematics courses in Midwestern Community College prepare students for on-level mathematics coursework.

Research Questions

1. How does educational scaffolding in supplemental mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?
2. What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?

3. What factors or teaching strategies used in supplemental mathematics do students credit for their eventual success in on-level mathematics courses?
4. How do students describe the preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?
5. How are the scaffolding techniques of cognitive structuring, questioning, feedback, instruction, and modeling utilized in these successful supplemental mathematics classrooms?
6. What barriers exist that might prevent instructors from using educational scaffolding?

Researcher Role

Researcher Bias

It is crucial to recognize the factors that may influence a study. The primary factor that could have influenced my role as researcher is my background. I have been teaching mathematics for 14 years. I taught K-12 for 10 years, during which I was also an adjunct at two different community colleges. The first community college taught developmental mathematics as a sequence, whereas the second taught developmental mathematics as a sequence until it redesigned its mathematics program as a corequisite supplemental mathematics course. At present, I am a full-time instructor at a satellite campus of Midwestern Community College, which has a main campus and two satellite schools. Each campus is unique and little interaction occurs between them, except for introductory school meetings for the fall and spring semesters.

To limit any potential bias, I collected data from the main campus of Midwestern Community College – in other words, I did not collect data from the campus where I

teach. I recorded any preconceived thoughts and ideas that I might harbor about supplemental mathematics in a separate journal so that they were named and acknowledged. This helped to prevent me from subjectively influencing my interviews, observations, or document and data analyses. I also recorded any decisions on my part that affected the direction of my study in the journal. In addition, I addressed this bias through a process of triangulation, which involved using multiple sources of data to support interpretations (Guion et al., 2011). By collecting and analyzing a high number of data sets in my research, I reduced the possible interjection of bias.

Research Design

A research design refers to how the researcher sets up and performs their study. It aligns the purpose, research questions, data collection, and data analysis. Many approaches to qualitative research exist; therefore, it was imperative for the research design to be aligned to maintain the integrity of the study. The research design comprised eight components, namely the research methodology, research philosophy, research type, research strategy, time horizon, sampling strategy, data collection method, and data analysis techniques (Grad Coach, 2021). In the following subsections, I explain and justify how these eight components were used in this study.

Rationale for the Methodology

A qualitative methodology was used in the study, which focused on obtaining a deep understanding of how successful supplemental mathematics teachers prepared their students for on-level coursework. This design aligned with the epistemological perspective, constructivism, as the qualitative researcher aims to gain a deep understanding of how people construct their world (Merriam, 1998). In this study, I used

a qualitative methodology to gain a holistic understanding of the participants' perceptions of their experiences with these supplemental mathematics classes. Furthermore, the research questions were asked in a manner that aimed to acquire that deep understanding. A quantitative analysis was unsuitable for this study because it would have imposed certain limitations that would have prevented me from understanding participant perspectives in-depth.

Research Philosophy

Constructivism was the epistemological perspective employed in this study. According to Crotty (1998), constructivism is the truth that comes from engagement into the world, and "meaning is not discovered, but constructed" (Crotty, 1998, p. 9). Educational scholars may further define constructivism as the process through which students construct new knowledge by integrating it with existing knowledge (Merriam, 1998). The supplemental teacher's role is to help students build their understanding of mathematics through this process of integration. In this study, knowledge was constructed through the interactions between instructors and students in the supplemental mathematics classroom, and I noted how those interactions changed lessons, teacher strategies, and content to help students prepare for their on-level course (Alzahrani & Woolard, 2013).

Because this research was interpretive, it relied on qualitative data. According to Ryan (2018, p. 45), "interpretivism argues that truth and knowledge are subjective, as well as culturally and historically situated, based on people's experiences and their understanding of them." Experiences were the focus of this study, and specifically those of the students and instructors in the supplemental mathematics classroom.

Constructivism helped me to understand said classroom, its components, and how the instructors prepared students for on-level mathematics courses. Furthermore, it revealed the interactions in the classroom and how new knowledge was connected with known knowledge, thereby creating new meanings and advancing students in the mathematics learning process; therefore, constructivism was a fitting perspective to adopt because it aligned with Crotty's (1998) explanation.

Research Type

Since I used a qualitative method, an inductive approach was appropriate for this study. The research process started with the collection of data through observations, document collection, and interviews. I then looked for patterns and themes at the end of the research process as a result of the data collection. The inductive approach has the following three goals: to condense the data into a summary format, to demonstrate links between the research questions and data summary, and to develop a framework that emerges from the data (Thomas, 2006). This approach has also been demonstrated to provide reliable and valid results (Thomas, 2006).

Moreover, the inductive approach was not only fitting for this study because it is qualitative in nature but also because it fit the study purpose and was appropriate for answering the research questions. The inductive approach produced meanings from the data collected, which then led to themes. The purpose of this study was to explore, through the lens of Vygotsky's Model of the Zone of Proximal Development, how successful instructors of supplemental mathematics courses at Midwestern University prepare students for on-level mathematics coursework. I used the inductive approach to

collect data, analyze them, and then develop themes based on the patterns that emerged from them.

Research Strategy

This research was a case study, which is "an in-depth description and analysis of a bounded system" (Merriam, 1998, p. 37). In this context, a bounded system means that the case is separated in terms of time, place, or other physical boundaries (Meriam, 1998). In qualitative research, a case study aligns with a constructivist epistemological perspective because it seeks to gain a comprehensive understanding of the phenomenon (Merriam, 1998). An example of a study that employed a qualitative case study design with an epistemological perspective of constructivism is that of Tuncel and Bahtiyar (2015). They conducted a qualitative case study to gain an in-depth overview of how knowledge was constructed in the teacher-learning process.

In the present study, a case study was appropriate because it provided for an in-depth description and analysis of participant perceptions of their experiences in selected supplemental mathematics courses. The case, specifically, was successful supplemental instructors and their students at Midwestern Community College over the course of a semester. This case study was done at Midwestern Community College main campus in the first half of the Fall of 2022. The supplemental class was a zero-level class that was face-to-face or O-Live taken concurrently with the on-level course. The course could be taken any day or time of the week as long as it did not interfere with the on-level course. The course also ranged from 1 to 2 credit hours. The students could be exempted from the supplemental class in the 12th week if they were making an A or B in their on-level

course. In addition, since this was a qualitative case study, I collected multiple types of data including, interviews, documents, and observations.

Time Horizon

Since this study was a case study and was thus bounded, the data were collected over a predetermined period of time, namely one semester (Merriam, 1998). Several considerations informed my decision to collect data over this predetermined period. The main reason was that supplemental students are ideally only enrolled in supplemental mathematics for one semester alongside their on-level course. Finally, students at a community college often have limited time outside of their studies because they have jobs and family obligations; thus, they may struggle to make time outside of class or beyond the semester to meet with a researcher

Sampling Strategy

I used purposeful criterion sampling which allowed me to select information-rich participants to answer the research questions (Merriam, 1998). This type of sampling uses a specific criterion to select a sample. I selected two successful instructors of supplemental mathematics, who were deemed successful as they had a large percentage of students passing on-level mathematics. The instructors were also required to have taught supplemental mathematics for more than 1 year and could be a part-time adjunct or a full-time faculty. Furthermore, I selected six successful students, based on instructor recommendation, who had taken less than 16 college credit hours within the last 20 years; however, as mentioned earlier, only five were able to participate. These students had made considerable progress in the course according to their teacher's perception. The students' progress was from the beginning of the course until halfway through it. The aim

of using purposeful criterion sampling was to gain deep information about the case, which is consistent with a qualitative study's purpose (Suri, 2011).

Participant Selection

I selected my sample from students enrolled in supplemental mathematics during the Fall of 2022, the semester in which I conducted data collection. I also selected two instructors who teach supplemental mathematics at Midwestern Community College. My sample ultimately comprised five students and two instructors. This sample size allowed me to conduct in-depth interviews with my participants. Furthermore, I selected students who were incoming freshmen, while the instructors could be full-time faculty or part-time adjuncts; however, both instructors were full-time instructors. I also set a criterion for instructors of having taught supplemental mathematics for more than 1 year. The sampling strategy enabled me to obtain an information-rich sample for the study (Cohen & Crabtree, 2006). Table 3.1 outlines my selection criteria for student and instructor participants:

Table 3.1

Participant Selection Criteria

Participant Group	Sample Size	Selection Criteria	Rationale

Students	5	• Taken less than 16 college hours taken within the last 20 years. • Enrolled in supplemental mathematics. • Made considerable progress in on-level mathematics from the teacher's perspective.	Such students would have knowledge about the current activities taking place in the classroom since they were enrolled. The students informed the researcher how they were prepared for on-level mathematics and why they had been successful.
Instructors	2	• Taught supplemental mathematics for more than 1 year. • Adjunct or full-time faculty. • Currently teaching supplemental mathematics. • Successful	Such instructors would have some experience, which would help to explain interactions in the classroom. They were currently teaching supplemental math; thus, they were aware of new teaching methods for preparing students. They were also considered successful; thus, they could provide insights into how they prepare successful students.

Data Collection

Before collecting the data, I sought IRB approval for my study. The IRB approval letter is provided in Appendix E. To avoid researcher bias in a qualitative study, using various methods for data collection is critical (Merriam, 1998). Therefore, I collected the data through interviews, observations, and document collection. Using a wide variety of data collection methods helped me to obtain an in-depth understanding of the case as well

as triangulate the data to minimize bias. Each method is separately explained in the following subsections.

Interviews

Interviews allow researchers to obtain high-quality information from study participants (Patton, 2015). However, the interviewer must be skillful to obtain high-quality information. Interview questions should include open-ended, probing, and follow-up questions. The questions must be clear and understandable, and it must be possible to answer them (Patton, 2015).

I gave each interviewee an IRB consent form, which is provided in Appendix F. I followed a semi-structured interview protocol with both instructors and students to obtain different viewpoints on classroom activity and the techniques being used to prepare students for on-level coursework. As previously mentioned, I interviewed two instructors and five students. The interviews provided a vivid description of the supplemental mathematics classroom. The interview protocols for instructors and students are provided in Appendix A and Appendix B, respectively. In addition, work schedules and the COVID-19 pandemic were a notable factor that meant that some participants were uncomfortable or unable to do in-person interviews. I therefore offered the option of conducting interviews through Zoom, Microsoft Teams, or telephone. These platforms allowed the interview format to be flexible and helped the interviewees to feel comfortable with the process.

Observations

Observation refers to a fieldwork description of ongoing behavior and events that the researcher observes in participants' natural situation (Merriam, 1998). Such events

and behaviors can include activities, actions, conversations, interpersonal interactions, or any other observable human behaviors (Patton, 2015). Observational data allow the researcher to further understand the case being studied. To minimize researcher bias, it was crucial to follow an observation protocol (Merriam, 1998). I observed both the instructor and student interviewees during multiple supplemental mathematics classes. In conducting the observations, I had certain expectations of things that would occur in the classroom and observed for them. I both expected that, like most classrooms, the supplemental instructor would use a lesson plan and have minimal unplanned activities, and I observed for these elements. Moreover, I expected and observed nonverbal communication among the students and teacher. I also observed the students' level of understanding through their facial expressions. Furthermore, I observed posture as it is usually an indicator of whether someone is paying attention. I saw that some students' visual cues indicated understanding, whereas those of other students did not.

In addition, I observed nonverbal cues of the instructors and students. Such observations provided insights into learning comprehension among students. Indicators such as facial expression and body posture served as cues to the level of understanding among students. Furthermore, verbal cues provided insights for my research. The teacher–student interactions alerted me if any deviations occurred from the traditional lesson plan. In observing verbal and nonverbal cues, I gained more knowledge about the social phenomena in the classroom. These observations not only furthered my knowledge of the case but also helped me to answer my research questions.

Document Collection

Collecting documents allows the researcher to capture materials and preserve the context (Patton, 2015). Documents are the most objective suppliers of information, and there is little risk that they will introduce bias, which is a stronger possibility in other collection methods, such as interviews and observations (Merriam, 1998). I collected syllabi, worksheets, teacher notes, and student work. I requested that the teachers email or provide copies of any additional documents, such as teacher notes or other online resources that the teachers used to support student learning. The data collection strategies and how they aligned with the research questions are presented in Table 3.2.

Table 3.2

Data Collection Strategies

Research Questions	Interviews	Observations	Documents
How does educational scaffolding in supplemental mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?	Interview transcription	Observation notes	Student assignments
What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?	Interview transcription	Observation notes	Syllabi, instructor documents, student assignments
What factors or teaching strategies do students credit for their	Interview transcription		

eventual success in on-level mathematics?			
How do students describe their preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?	Interview transcription		Worksheets
How are the scaffolding techniques of cognitive structuring, questioning, feedback, instruction, and modeling utilized in these successful supplemental mathematics classrooms?	Interview transcription	Observation notes	Instructor documents, student assignments
What barriers exist that might prevent instructors from using educational scaffolding?	Interview transcription	Observation notes	Syllabi, instructor documents

Data Analysis

Merriam defined data analysis as "how we make sense of data" (Merriam, 1998). I followed Creswell's six-step process for analyzing data (Creswell, 2014). The six steps were as follows: organizing the data, reviewing all of the data, coding the data, developing themes from the coding, demonstrating how the themes were represented in the case, and interpreting the findings. This six-step process helped me to develop the themes, which then helped me to answer my research questions.

Furthermore, I used Merriam's constant comparative method of data analysis to code my data. Merriam explained that data collection and analysis occur as concurrent activities in qualitative research (Merriam, 1998). After my initial data collection, the insights that I gained from the data drove my next phase of data collection (Merriam, 1998). This was iterative in nature because it was a systematic, repetitive, and recursive process used to adapt the data collection to provide further insights (Merriam, 1998). After the completion of every interview, observation session, and collection of documents, I wrote a reflection on each experience. I then transcribed the interviews as soon as possible and coded the data. I followed the same process with observations and document collection.

In the early stages of data analysis, I used open coding followed by organizing data into categories. Merriam (1998) describes these steps as a systematic process of organizing data by properties. I then used axial coding to determine the relationships among open codes (Merriam, 1998). These codes identified categories and themes that helped to explain the data. The themes were chosen if they aligned with the study's purpose and represented the data fully. Then the findings were interpreted by using the theoretical framework, the Zone of Proximal Development with educational scaffolding. Finally, I analyzed the thematically separated data to find information that helped spotlight the themes. This often included finding information such as quotes that were included in the last two chapters.

Trustworthiness of Findings

Lincoln and Guba (1985) described how the trustworthiness of qualitative research can be improved. They indicated four criteria of trustworthiness, namely

credibility, transferability, dependability, and confirmability. A brief description of each criterion is provided in the following subsections.

Credibility

Credibility refers to whether the research findings are considered a credible interpretation of the original data gathered by the researcher from participants (Merriam, 1998). Strategies that can be used to establish credibility include prolonged engagement, triangulation, purposive sampling, and journaling to prevent or minimize bias (Merriam, 1998). Using these strategies enabled me to be more confident in the findings.

Transferability

Transferability is defined as the degree to which the results of qualitative research can be generalized or transferred to other similar contexts or situations (Lincoln & Guba, 1985). The primary strategy that I employed is the provision of a thick description of data (Lincoln & Guba, 1985). A thick description of data refers to providing a detailed account of the observations made in the field; in this case, the observations were made in the classroom. The thick description included both physical behaviors and the context in which they occurred, which should allow an outsider to understand the situation.

Dependability

Dependability is defined as the consistency and reliability of the researcher's findings and the extent to which all procedures are strictly documented; thus, someone who is not involved in the research should be able to follow, audit, and evaluate the research process (Merriam, 1998). The primary strategy that I employed was to create a brief audit trail (Merriam, 1998), which established the dependability of the study

through the provision of a sufficient amount of information for researchers to reconduct the study in the future.

Confirmability

Confirmability refers to the degree to which a study's findings can be confirmed by other researchers and the neutrality of the researcher in the study's findings. It involves establishing that the data and interpretations of the findings were in fact clearly derived from the data, as opposed to somehow being created by the researcher based on what they imagined to be true (Merriam, 1998). The principal strategies that I employed to ensure confirmability were an audit trail and journaling of decisions and biases that could have influenced the study (Merriam, 1998).

Table 3.3 provides a more detailed description of the four criteria of trustworthiness in the present study:

Table 3.3

Trustworthiness of the Findings

	Results	Examples
Credibility		
Prolonged engagement	*Built trust.* *Built relationships.* *Ensured a wide scope of data.*	Observations occurred for one semester. Communicated with instructors regularly through Zoom, face-to-face, email, and text.
Triangulation	Verified the data.	Collected data via interviews, observations, and documents

		Interviewed both instructors and students
Purposive sampling	Selected the correct site and participants with supplemental mathematics.	Interviewed participants who were selected using strict criteria.
Journaling	Documented preconceived biases about supplemental mathematics and any researcher decisions.	Pre- and post-interview as well as observation thoughts recorded in a journal.
Transferability		
Thick description of data	Helped to explain the environment to the reader. Helped to answer the research questions.	Wrote an in-depth description of participants, observations, the site, and interactions.
Dependability/Confirmability		
Audit trail	Permits an auditor to determine trustworthiness.	All data were stored in a folder and made available for audit.

Limitations of Study

This study had some limitations. In this case study, I sought to gain participant perspectives. Some of the participants gave good information but did not always explain their perceptions further when I asked follow up questions. Therefore, I collected multiple forms of data and triangulated the data to reduce the potential for this limitation. As a researcher, I spent extended time at the site to help gather the best possible explanation of how these instructors support student learning in their classrooms. There is a possibility for bias in every qualitative study that may influence the results. It was my

job as a researcher to limit bias. Therefore, I recognized the experiences and viewpoints that I brought into the study, and I did my best to listen to the voices of participants so that findings reflect their voices. Finally, there were some limitations due to the COVID pandemic and work schedules including conducting some interviews on Zoom rather than in person.

There was also a delimitation for this research study. The theoretical framework was the lens that I used to conduct the study. It narrowed the scope of the study and is the way in which I conducted my observations, formulated research questions, and collected documents. It also affected my data analysis as I was constantly keeping it in mind as my themes and results of my research questions developed. This delimitation was chosen so I could use the ZPD with educational scaffolding to understand how students moved from dependent learners to independent.

Summary

In this chapter, I have described the methodology that I employed to conduct this case study. I also discussed my role and potential bias as a researcher. Furthermore, I described the research design, which comprised the following eight components: the research methodology, research philosophy, research type, research strategy, time horizon, sampling strategy, data collection method, and data analysis techniques. This was followed by a discussion of how I ensured the trustworthiness of the research. Chapter 4 presents the findings of the study.

CHAPTER IV

FINDINGS

This chapter presents the findings from this qualitative case study, which was conducted at Midwestern Community College (MCC, a pseudonym). The purpose of this study is to explore, through the lens of Vygotsky's Model of the Zone of Proximal Development (ZPD), how successful instructors of supplemental mathematics courses at Midwestern Community College prepare students for on-level mathematics coursework. The following research questions guided this study:

1. How does educational scaffolding in supplemental mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?
2. What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?
3. What factors or teaching strategies used in supplemental mathematics do students credit for their eventual success in on-level mathematics courses?
4. How do students describe the preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?

5. How are the scaffolding techniques of cognitive structuring, questioning, feedback, instruction, and modeling utilized in these successful supplemental mathematics classrooms?
6. What barriers exist that might prevent instructors from using educational scaffolding?

The goal of this chapter is to present themes that emerged from the data analysis and to answer each research question. First, a detailed description of MCC is presented to the reader, including its setting, history, and relevant elements. These elements of the school include its demographics, enrollment, class size, math faculty, and supplemental math classes. Next, readers are introduced to the participants of the study with a profile of each interviewee and a synopsis of each interview. Pseudonyms are provided for all participants and sites to protect the participants' privacy. Next, I present detailed descriptions of the observations that I conducted as well as describe the items that I collected from the instructor. Then, I discuss each of the themes that emerged from the data analysis. Finally, I answer each of the research questions based on the findings from this study.

Data Presentation

This section will help the reader understand the setting of the study. First, MCC is presented in detail, including its setting, history, and relevant elements, such as its demographics, enrollment, class size, math faculty, and a description of supplemental classes. I follow that description with a profile of the interviewees and a brief synopsis of each interview. Finally, a detailed description of the observations that I conducted is presented along with documents that I received from the instructor.

Main Campus Setting

MCC's main campus is located in a small Midwest town known as Wheat Heart (a pseudonym). The population of Wheat Heart is slightly less than 3,000 people and has been declining over the past 2 decades. The demographics of Wheat Heart are presented in Table 4.1:

Table 4.1

Wheat Heart Demographics

Descriptor	Percentage
White	78.57%
Two or more races	9.30%
Other race	5.13 %
Native American	4.93%
Asian	1.47%
Black	.60%

Note. Adapted from World Population Review (2022).

The predominant jobs in Wheat Heart are in farming, the energy sector, and at MCC. The large farming community and energy sector were evident on my drive into Wheat Heart, where I observed many open fields of crops growing and a huge energy plant. The town has an unemployment rate of approximately 5% (Wheat Heart, 2022); however, poverty does exist, which along with a declining population, presents MCC with challenges that

are common to small rural community colleges. In the following section, MCC is thoroughly discussed.

The School: Midwestern Community College

This section describes the history, mission, and relevant elements of MCC.

History

MCC opened its doors in 1901 when a legislator from Wheat Heart realized the need for a college in the rural Midwest. The legislature passed a bill that led to the creation of a preparatory school, which opened with only seven instructors and 217 students. In its early days, MCC served as a feeder institution to a large four-year university in Oklahoma. MCC paralleled the curriculum with the large four-year university for students to ensure an easier transition. Furthermore, MCC added a fine arts program that continues to develop to this day (College Website, 2022).

The Higher Education Federal Code of 1965 created the present-day MCC (College, Website, 2022). The act provided educational resources and financial help to students in higher education. It also allowed MCC to expand the MCC State Board of Regents from three to five members, expand curriculum, and increase student enrollment. MCC has also expanded into two additional separate towns. In addition, MCC has made several technological improvements to reach students in more remote areas, who would otherwise not have access to a college degree.

Mission

The mission of MCC is to provide a "high quality, accessible, and affordable educational opportunities and services which create life-changing experiences and develop students as effective learners and leaders" (College Website, 2022). MCC

accomplishes this mission through its core values of personalized education, community and civic engagement, and continuous improvement. MCC provides for a personalized education by providing supports in and out of the classroom, including tutoring or counseling for students. MCC provides for community and civic community engagement through involvement in the community. It offers activities and camps for students K-12, invites the community to plays, and is involved in other Wheat Heart activities, such as local parades. Finally, MCC is continually working to improve students both personally and professionally through activities on campus and rigorous classes.

Relevant Elements

Demographics. The demographics of MCC are slightly more diverse than the town of Wheat Heart. They are presented in Table 4.2:

Table 4.2

Midwestern Community College Demographics 2021–2022

Race	Percentage
White	62%
American Indian	17%
Hispanic	10%
Black	5%
Two or more races	3%
Asian	1%
Nonresident alien	1%

However, MCC demographics are less diverse than the those of the average national community college, which in the 2021–2022 school year were 45% White, 25% Hispanic, 13% Black, 7% Asian, and 10% other (CCRC, 2022). Additionally, students of the average national community college are predominantly female, with 55% female students and only 45% male (Beer, 2018). MCC has just a slightly higher proportion of female students, with an overall community college enrollment of 61% female and 39% male. The students are also relatively young at MCC: 5% are younger than 18, 78% are aged 18–24 years, and 16% are aged 25–64 years. Thus, MCC is slightly younger than a traditional national community college, where 51% of students fall into the 18–24 age group and 49 % fall into the 25-64 age group (Beer, 2018).

Enrollment and Class Size. The enrollment for community colleges across the nation has been in decline (Leckrone, 2022), and MCC is no exception. The current enrollment at the main campus is approximately 600 students. The declining enrollment has been exacerbated by a decreasing town population, a lower percentage of people going to college, the COVID-19 pandemic, and new admission standards for four-year universities (Brooks, 2020). According to MCC they have lost 42% in credit hour production over the last 2 decades for all campuses. Furthermore, the town has seen more people move away to urban areas or attend other universities that are less expensive. Moreover, the COVID-19 pandemic created health and economic concerns, which caused a significant drop in enrollment. Finally, since the COVID-19 pandemic, many four-year universities have switched to test-optional admissions; thus, they attract many of the students who would have attended a community college, thereby decreasing enrollment (Howell et al., 2021).

The class size at MCC averages 17 students to one instructor. MCC aims to maintain low class sizes to provide students with a more personal experience. However, 17 is just an average for class size, and class sizes fluctuate depending on the subject and semester. General education classes have a higher enrollment than specialized classes, as many students have either transferred by the time they reach specific major coursework or have entered the workforce. In addition, a significant decrease in enrollment occurs from fall to spring, which leads to lower class sizes. In fall, classes average 25–30 students; whereas, in spring they average 12–20 students. In this study a large class size was 20 or more students.

Math Faculty. There are five math faculty members at MCC's main campus. They are all White, female, and aged from their 30s to their 60s. In addition, each faculty member has a master's degree, although not necessarily in mathematics. The degree requirement is that they have a bachelor's degree and 18 hours of graduate courses in mathematics. Furthermore, all math faculty members teach for at least 15 hours a semester, advise and enroll students, serve on two committees, and help to sponsor a club or activity on campus.

Supplemental Math Classes. MCC had sequential mathematics, in which students had to enroll and pass three to four remedial math classes before they were allowed to take an on-level math class for college credit. MCC began offering a corequisite supplemental math class as part of the Math Pathways project and the state's commitment to reducing the number of remedial classes required by students in college. Students enroll in on-level mathematics along with their supplemental class. Furthermore, there are different supplements for every math class. MCC has Supplement to Functions,

which is a 1-credit-hour class that lasts 50 minutes. It is taken at any time of the week as long as it does not interfere with the on-level Math Functions class. MCC also offers Supplement to Algebra for STEM, which is a 2-credit-hour class that lasts 50 minutes. It is taken twice a week and cannot interfere with the on-level course Algebra for STEM. In an effort to boost enrollment and access to education, MCC is also offering an O-Live option for supplement, where students can join a supplemental class via Zoom. The students join the supplemental class at the same time but are instead on a computer and not in the physical classroom with the instructor. Through this online opportunity, a student does not have to travel to the physical classroom to be enrolled in supplement.

MCC immediately saw some success in switching to a corequisite supplemental class. In pre-pandemic times, course instructors were beginning to notice a larger increase in passing of non-STEM on-level mathematics, such as Math Functions classes, and also a slight increase in Algebra for STEM classes. Since the pandemic, fewer students have passed their on-level class; however, there has still been an increase since the switch from sequential mathematics to the corequisite class.

Furthermore, a large need exists for increasing the class size and number of supplemental classes at MCC. Four math faculty members teach supplemental mathematics on the main campus. Although the class size is designed to be small, they are usually larger in fall with approximately 20–25 students, compared with fewer than 20 students in spring. Depending on course availability, the students could have the same or a different instructor for their on-level course. The students must attend the supplemental class; after three absences, they could be dropped from the supplemental class as well as their on-level class. Starting in the 12th week of the course, if a student

maintains an A or B in their on-level class and an A, B, or C in their supplemental class, the student can stop attending the supplemental class. This structure is designed to encourage and increase pass rates of on-level courses. The following section describes the participants of this study and presents a brief synopsis of their interviews.

Participant Profiles and Synopsis of Interviews

This section introduces each interview participant and provides a synopsis of each interview. Table 4.3 presents an overview of participants' demographics, gender, and role in the study. Following the table, a more detailed description of each interviewee and synopsis of each interview are provided.

Table 4.3

Participant Snapshot

Participant*	**Role**	**Ethnicity**	**Gender**
Liz	Teacher	White	Female
Lucy	Teacher	White	Female
Annie	Student	White	Female
Carrie	Student	White	Female
Sahel	Student	Asian	Male
Rose	Student	Native American	Female
Andi	Student	Native American	Female

*Pseudonyms were given to all participants.

Instructors

Two instructors participated in this study. The following descriptions provide the background of each instructor and a synopsis of their interviews:

Liz. Liz has been an instructor at MCC since 2015. Liz is in her 60s and has three adult children as well as some grandchildren. Prior to coming to MCC, she obtained a master's degree in education, was a computer analyst for 7 years, took time off to raise her children, and then worked in public schools for an additional 13 years. Liz is well liked in the department and frequently goes out of her way to help faculty members when they need support. For example, Liz helps by subbing if another instructor is absent, works with other faculty if they are struggling to reach a student, and helps bring faculty together through social activities. Outside of work, Liz and her husband own a farm where they raise cattle.

Liz appeared highly willing to be interviewed given her relaxed demeanor. She stressed multiple things about the supplemental classes and discussed some of the crucial factors that helped instructors and students. She stressed relationships with students, communication with colleagues, and a willingness to try to get a student to "meet her halfway" to help them succeed. She also discussed the barriers which prevented some students from succeeding. These included rising supplemental class sizes and the use of Zoom.

Lucy. Lucy has been an instructor at MCC since 2001. She is in her 40s and has an adult son as well as a daughter who is in high school. Prior to coming to MCC, Lucy studied at MCC as a student, obtained a master's degree in education, and has been at MCC since her 20s. In the 2021–22 school year, she was voted teacher of the year at MCC. The students rave about Lucy, saying that she is a great teacher. She is also involved in her church and other Wheat Heart activities.

Although Lucy is one of the younger MCC instructors, she has the longest tenure of all of them. Her experience led to a wealth of information in her interview. She offered an in-depth description of students and explained how she worked with them to succeed, how her classroom fostered their growth, and how she used other resources to help them. Lucy was also open about some of the barriers working against student success. The information that I gained from Lucy was highly valuable.

Students

Five students participated in this study. The following descriptions provide a background of each student and a synopsis of their interviews.

Annie. Annie is in Liz's class Supplement to Math Functions. She is an 18-year-old freshman who lives on campus and is from Ohio, where her parents live with her younger brother. She came to MCC to pursue an agriculture business degree. Furthermore, she is financially independent and is required to pay her college costs. She has been heavily involved with agriculture her whole life and currently works for the sheep center. Annie hopes to eventually transfer to a large four-year university in either Kansas or Oklahoma.

In her interview, Annie portrayed confidence and independence. She stressed that she was not good at math in high school and could "make no more than a C." However, Annie is now succeeding in math in college. She enjoys the supplemental class because it "provides extra help." In high school, Annie felt that she was never able to ask questions to her teacher. However, in her interview she stressed that she was able to ask questions in the supplemental class because of the relationship she had developed with her instructor. She specifically stated that she was able to ask her instructor questions about

concepts that she did not understand. Annie also uses WebAssign to "practice another version" to work on concepts when she needs further instruction. Annie has also developed relationships with two other students in the class and calls them her "best friends." She has formed a study group that meets to study for homework and exams. Overall, Annie enjoys the extra help provided and the relationships she has made with the instructor and students.

Carrie. Carrie is in Liz's class Supplement to Math Functions. She is a 19-year-old college freshman who lives in an off-campus apartment. As a child, she moved frequently around the Midwest; therefore, she does not consider herself to be from one particular place. She graduated from high school in Arkansas but spent many years in Colorado, Oklahoma, and Kansas. She decided to attend MCC because it was less expensive than a traditional four-year college or university. Carrie is working more than half the time and must pay for her college and living expenses. She is an agriculture science major and hopes to be an agriculture teacher in a small town in Oklahoma. To accomplish this goal, she wants to transfer to a four-year university in Oklahoma.

In her interview, Carrie was highly upbeat and enjoyed talking about school and her experiences in the supplemental class. Carrie has not done well in mathematics in previous math courses due to constantly moving and experiencing differing expectations among states. However, regarding the supplemental class she said, "I feel more at ease and now have a high B." Furthermore, she mentioned, several times, that her ability to ask questions in the supplemental class made her feel more comfortable. Moreover, she stated the following: "It's not a sit-and-do-nothing class. I ask a lot of questions to gain a better understanding." Carrie went on to say that the instructor "pushes us to think, is

patient, and does not just say the answer." She felt that the supplemental class went more in depth than the on-level class; however, she also wishes that the class met more than just 1 day a week because more material could be covered. In the class, she has developed close relationships with other students and made study groups to review the material for homework and exams. Carrie went on to say that "supplement has helped me a lot in math functions." Carrie definitely portrayed her confidence in the subject throughout the interview. She was excited to be doing well in a math class.

Sahel. Sahel is in Liz's Supplement to Math Functions class. He is an 18-year-old freshman who has an extraordinary background. He was raised in Burma but had to leave his home country due to war. He went to Malaysia for 2 years and lived in a refugee camp. His parents and five siblings then got the opportunity to move to Lincoln, Nebraska. They lived there for 2 years before finally moving to Tulsa, where his family resides. He came to MCC to play soccer and because the cost of education was relatively lower than other options. Sahel is majoring in personal training and has ultimate goals of transferring to a four-year university and becoming a soccer coach.

Sahel portrayed confidence in his interview. Despite the many challenges in his young life, he is now thriving at MCC. He enjoys the supplemental class because it "prepares you for the test." He frequently mentioned that if he does not understand something, then he will ask a question in class or during office hours, seek help from Tutor.com or WebAssign, and obtain help from the free tutor in the library. He explained that he has trouble with word problems because he does not always understand the language, but he feels very comfortable asking questions in class. He also likes the

supplemental class because it helps him to "understand the material." Sahel feels as though the supplemental class has helped him to do well in his on-level class.

Rose. Rose is in Lucy's class Supplement to STEM. She is an 18-year-old freshman from Oklahoma who lives at home with her parents, approximately 20 minutes from MCC. She comes from a large blended family with seven siblings. Her major is pre-veterinary medicine, and she eventually wants to transfer to a four-year university to complete her degree. Rose does not work and is dependent on her parents financially. Rose attended an alternative high school in northern Oklahoma that offered all coursework online. MCC has been the first in-person learning experience she has had for a few years.

Rose seemed very shy in her interview, as she mentioned that she had not interacted with many people since coming to college. Rose mentioned some key points several times during the interview: she enjoys the supplemental class because of the repetition of information from the main class, its slower pace, and the relationship she has developed with the instructor. Furthermore, Rose feels better in class because her professor makes her "feel comfortable, not nervous." Rose uses tools on WebAssign and Tutor.com if she is struggling at home or needs extra practice. Rose said that "the supplement class has been very helpful." This sentiment was echoed throughout her interview.

Andi. Andi is in Lucy's class Supplement to STEM. She is a nontraditional student. Andi is 44 years old and is in college for the first time. Furthermore, she has two grown children who are also in college. She works full-time for the Pawnee tribe and wanted to go back to college to advance in her job within the tribe. Andi only takes math

in person, while she takes the rest of her classes online so she can maintain a full-time job. At this point, she wants to obtain an associate's degree and not transfer to a four-year institution.

Andi was at first intimidated when she stepped into math because of all the young college students. However, she said, "the instructor put me at ease that I can ask anything and not feel bad." Andi has since "opened up" in class and works with her classmates and the instructor on the material. Since Andi works full-time, she enjoys how accessible the professor is to the students. Andi said, "I can text or email when I am studying any time of the day up to a point in the evening." Andi works approximately 4 hours a week outside of the classroom on homework and also studies for exams for another 4 hours. Andi feels as though the instructor is preparing her for exams, homework, and quizzes. Throughout her interview, she was highly positive about the class.

Observations and Documents

I observed two supplemental mathematics classrooms at MCC. Liz's class was Supplement to Math Functions. Class meetings are held early in the morning, and enrollment consists primarily of traditional college students. Lucy's class was Supplement to Algebra for STEM. This class meets on Monday and Wednesday nights and consists of both traditional and nontraditional students. I obtained the syllabus for each supplemental class and the related on-level courses to examine their objectives and to understand how they compared. I also examined the instructors' notes to determine the different preparation techniques used. Finally, I examined the worksheets, cards, student work, and any other documents the instructors handed out to their students.

I conducted four 50-minute observations of each class throughout the first half of the Fall 2022 semester, for a total of eight observations. I acted as a nonparticipant and did not engage with the instructor or students. I took field notes during each observation, used an educational scaffolding table to help identify examples of how the instructors prepared students, collected documents that the instructors used, and wrote a reflection in my journal after each observation. Furthermore, I looked for the methods used by the instructors to prepare students for on-level classwork. Table 4.4 presents the table that I used in class to record examples of educational scaffolding techniques in each class. These examples are followed by a chronological description of my observations throughout the different class segments that included lecture, groupwork, and one-on-one time. The classes were taught very similarly, with each having the same defined segments, but the instructors spent different amounts of time on those segments.

Table 4.4

Observational Educational Scaffolding Techniques

Observation	**Cognitive Structuring**	**Questioning**	**Feedback**	**Modeling**	**Instruction**
1	Referred back to previous concepts. Taught students how to work the calculator by relating it to the material and only doing a part of it.	Called on students and asked them about the material. The students asked questions of the instructor for help.	Students scanned worksheets and cards and submitted online for feedback. Instructors went around the room to give feedback on	Showed further examples. Showed students different ways to receive extra help when they were not in class. Demonstrated tools on WebAssign, local	Used multiple ways to present concepts. Used multiple approaches, including lectures, one-on-one, groupwork, and

			worksheets and homework.	tutoring, and Tutor.com to assist with homework.	homework time. Students submitted their work by scanning and submitting it online for feedback.
2	Related exam-type questions to what the students had previously learned.	Instructor asked students why they applied certain methods to solve problems.	Students gave feedback to one another in groups and received feedback from the instructor.	Reviewed questions that might be in the exam. Helped individual groups with problems.	Provided helpful approaches for studying for upcoming exams and a strategy for success.
3	Instructor related average rate of change to the previous chapter when they first learned it and to concavity. Instructor demonstrated different strategies for finding vertex and a standard equation of parabola, relating it to completing the square	Instructor started easier asking questions to find average rate of change and then progressed to asking word problems.	Instructor gave feedback to students in one-on-one, groupwork, and the worksheet they were working on. Students also gave feedback to one another in groupwork and homework time.	Presented further examples from lecture. Worked with groups and individuals.	Started examples off with an easier approach and worked their way up to a higher level of thinking.

	and factoring.				
4	Categorized methods to solve systems of equations. Categorized ways to set up systems of equations from word problems	Instructor would frequently ask for the next steps of problems.	Instructor provided feedback to students one-on-one, in groupwork, and on the worksheet they were working on. Students also gave feedback to one another during groupwork and homework time.	Presented further examples from the lecture. Worked with groups and individuals.	Instructor asked basic problems of systems of equations and progressed to solving word problems.

Lectures

In Liz's class, she used the first 15–20 minutes to talk to students about how they are doing and further explain concepts taught in the on-level class. Liz used the document camera to review additional examples of math problems to help explain the concepts that were being taught. Liz walked around during this segment of the class. Students felt free to ask questions without raising their hands. They received help from Liz and other students sitting around them. Liz often repeated material or calculator concepts to the students when she saw they were lost or needed further explanation. Liz was

straightforward with students and talked to them both in front of the class and one-on-one if she assessed that they did not come prepared. She offered help if they could not afford a calculator or were facing other personal struggles. As there were several athletes in her class, their coaches frequently checked in during this time to make sure that their players were in class. This segment of the class was highly active even though it is considered a lecture.

Lucy arrived early and used the time before class to talk to students about what they were doing in their on-level class. She also engaged in discussions about just in life in general. In Lucy's class, she used the first 5–15 minutes to engage students by asking them about their homework and what concepts they were having trouble with in class. She then reviewed a few of these topics and homework questions using a document camera. For example, one of the concepts students said they were struggling with was factoring. Lucy explained factoring using a method called "slide and divide." There were some students who did not understand this method and told her so. The students did not raise their hand when needing help and instead just asked questions. Following the "slide and divide" explanation, she demonstrated another method called "factoring by grouping." Lucy utilized multiple methods to support student understanding. Although she did not spend much time on further explanations, they were of high quality and the students appeared to genuinely respond to her methods.

Groupwork

Following her lecture, Liz distributed worksheets to the class. These worksheets addressed material that had been presented in the students' on-level class. The worksheets were generated by the math department and distributed to all instructors to

use in their classrooms. An example of an average rate of change worksheet that Liz used is provided in Appendix C. The students worked through the worksheets in groups for 15–20 minutes. The groups were not assigned; instead, students worked with other students based on proximity. Liz sat at the front of the classroom while the students were working on their worksheets. If a group had a question, she would go to them and help. She did not rush and took her time whenever a group had a question. Liz had students take a picture of the worksheet and submit it online during class time. She utilizes these pictures to take attendance and grade student work.

Lucy passed questions to the students on worksheets and had students make them into cards for further study. These worksheets that she generated herself had questions over concepts the on-level class was covering at the same time. She simply presented those questions differently than most instructors who just had students fill out a worksheet. Lucy had the students make cards. An example of the questions that Lucy used in a factoring lesson are presented in Appendix D. Lucy told the students to write the problem on one side of the card and to solve the problem on the other side. She told them that this is a tool to use to study for quizzes and exams. Lucy's students spent 25–30 minutes on the groupwork. Sometimes, if Lucy noticed that the whole class was struggling, she would bring them back together and explain a concept. Lucy assigned her groups by proximity, with students working with those sitting next to them. As the students worked, Lucy walked around to help any students who needed help. Lucy had the students take pictures of the "worked-out examples" and submit them on the Blackboard, a server the instructors use to post assignments, receive assignments, and grades. Blackboard allowed her to do attendance and evaluation for students.

One-on-One

In both Liz and Lucy's classes, for the last 5–20 minutes (depending on the amount of extra time left), the students were allowed to work on their homework for their on-level class. During this part of class, the instructor sat at her desk for some of the time. All homework was done on the computer through the program WebAssign. The students sometimes appeared to have a frustrated facial expression while doing their homework; they also frequently asked other students for help if they had a question. Much collaboration and talking occurred during homework time. If students seemed frustrated for more than just a few minutes, both Liz and Lucy went over to help them. Many students in Liz and Lucy's classes chose to stay after the class had ended to continue to receive help. Lucy explained that students typically stayed with her for approximately 20 minutes to receive extra help on homework or various concepts.

Data Analysis

In this study, I collected data using interviews, observations, and document collection. To analyze the data, I utilized the constant comparative method (Merriam, 1998), which meant that I collected data, reviewed and coded data, and wrote a reflection in my journal during the data collection process. Merriam's constant comparative method allowed me to continually refine my data collection to ensure that I collected data that was needed to answer my research questions. For example, after conducting an observation or interview, I wrote a reflection and considered what I had seen and heard to create new lines of questions in the subsequent interviews.

Once I had collected all of the data, I continued with a deeper analysis using Creswell's six-step process (Creswell, 2014). I transcribed the interviews as soon as

possible. I followed the same process with observations and documents. I then organized all of the data by type. Then, I reviewed all of the interview transcripts, observation field notes, and documents that I had collected. I utilized the technique of open coding to code all interviews, field notes and document data. Next, I coded any additional critical pieces of information. After coding, I began to look for categories that emerged from the coding process. Open codes were placed into categories following an axial coding technique (Merriam, 1998). I then analyzed categories to identify themes that emerged and considered how the themes applied to the overall purpose of my study (Merriam, 1998). Keeping in mind the purpose of my study and the theoretical framework of ZPD with educational scaffolding, I identified six themes and four sub-themes that emerged from data analysis. Finally, I utilized the themes to answer my research questions.

The following section presents my findings from data analysis. These findings are presented under different themes. Each of the themes is explained including direct quotes from interviewees, details from observational data, and explanations of how documents were used to help understand the instructors and students of supplemental classes at MCC.

Themes

Through the in-depth analysis of the interviews, observations, and documents described above, the following themes emerged: Relationships, further explanations, collaboration, additional resources, communication, and barriers. There were also subthemes that emerged from themes. Those subthemes included: Confidence, WebAssign, Tutor.com, Zoom, and class sizes. These themes and subthemes aligned with the study purpose and research questions.

Relationships

Relationships, the first theme, were evident in both supplemental mathematics classes that I observed. In my interviews, observations, and document collection, I saw how relationships were crucial to both instructors and students. Furthermore, both instructors told me that they strove to build relationships with students on a weekly basis. Liz said the following: "Relationships are important because it makes the student more comfortable." Lucy said the following: "I am like their coach, counselor, and advisor all rolled into one." In my observations, both Liz and Lucy continually checked on students by name to see how they were doing, reviewed material if required, and constantly worked to ensure that all students actively participated. Lucy also publishes a midterm report, which seeks student input regarding their grade, the strengths of the supplemental class, and what she can do differently to help them. A copy of this report is in Appendix G. The use of this document helps Lucy to further the development of relationships with her students and also helps her to make changes to the class based on what the students need. The instructors said that if they could get a student to "meet them halfway," then they could bring them the rest of the way in the learning of the material.

The building of relationships helped to motivate students to ask questions and seek help from their instructors. Annie said the following: "I know my instructor cares about my success because she took the time to know me." The students were also able to build relationships with each other during groupwork. This interaction made them feel more comfortable asking questions of not only their teachers but also peers. Carrie stated the following, "I have made some great friends to study with in this class." Rose said the following, "The instructor makes me feel comfortable to ask questions." Another

example of relationship was evidenced when Sahel was unable to obtain a graphing calculator for his course. In response, his instructor, Liz, went out to get one for him from the bookstore. This gesture emphasized the relationship that Liz had built with this student. She recognized his need, and she was willing to find a solution that could support Sahel's success in the class. Relationships were mentioned frequently by both the students and instructors as the primary reason for their success.

Further Explanation

Further explanation of concepts, the second theme, was apparent in every observation and mentioned by every interviewee. In every class, the supplemental instructor began with examples, which the instructors told me were designed to help the students acquire an enhanced understanding of the material. The students stated that having those extra examples was extremely helpful because they did not always understand the concepts in the on-level class. The students felt that they could ask more questions freely in the supplemental class and not be embarrassed. Moreover, they felt that the instructor was trying to help them understand because they would often try another method to help them if they did not fully understand. The students felt that the on-level class was sometimes rushed and that these extra examples helped with understanding and confidence. Rose said, "the extra discussion on problems has been very helpful." This sentiment was echoed by all of the students. The confidence that the students displayed in their interviews and in the classroom was evident as an emerging subtheme from the time the class spent going over extra problems. The following section further analyzes the subtheme confidence.

Confidence

Confidence is a subtheme that emerged from the further explanation theme. Liz stated the following, "Most students have had that one bad math teacher in school that has shot their confidence in math." However, in the supplemental classes, the instructors used a variety of techniques to increase student confidence in their math skills. Annie said the following, "I've never been any good at math until I had this class." Students further explained that this increased confidence helps them be prepared for their on-level class. Annie continued, "I used to make no more than a C in math class, but now I have an A." Andi said, "The class has given me that confidence that I was lacking." Sahel explained that he is doing so well that he feels that he does not need the supplemental class anymore. Many students discussed some of the factors that boosted their confidence. These factors included the further explanations of the concepts learned in the on-level class, the ability to ask questions about concepts and homework, the positive feedback, and the instructors' attempts to make things easier by using different methods to explain concepts.

Collaboration

The third theme that emerged was collaboration. Findings in this study suggest that collaboration is critical in the classroom for student success. In my observations, the students always worked together in class to complete example problems, worksheets, cards, and homework. However, they appeared to genuinely try to answer their own homework problems before asking for help from peers. The worksheets and cards were designed to relate to concepts in the lecture to assist students' understanding. The instructor asked and answered questions from student groups while students were completing the worksheets. The students also frequently stated that the worksheets and

cards were helpful because the problems were similar to their homework, and the students also realized their scores on worksheets counted as a grade in the class, which helped increase their willingness to work. Collaboration among peers was also evidenced when the instructor was busy working with students around the classroom. Carrie said the following: "It was nice to not have to wait and just get help from another student while the teacher was working with someone else." Through establishing a collaborative environment, the instructor ensured that students were continually learning as they received help from the instructor but also from other students. During interviews, many participants stated that they learned a great deal from their peers when they worked together. This peer collaboration helped students gain needed understandings to complete their own work.

Additional Resources

The fourth theme that emerged was additional resources. The instructors offered many additional resources to students to assist them in understanding mathematical concepts. The following resources emerged as subthemes and were mentioned by instructors and students as aiding their understanding.

WebAssign

In all on-level math classes at MCC, the majority of homework is done online through the service WebAssign. Both instructors allowed their students to work on WebAssign during the last 15–20 minutes of class. Students reported that this resource was helpful for their understanding of the material. Rose mentioned that the "practice another version" feature of the WebAssign platform was very helpful. This feature on WebAssign gives immediate feedback on a similar problem to their homework and

allows a student to work towards the correct answer. Many students also mentioned additional tools that were helpful in WebAssign. For example, there was a button on each problem called "Watch it," which allowed students to view an example problem that was similar to their homework. The students could watch examples even when their instructors were not available. WebAssign allowed students to attempt multiple versions of the same problem until they understood it better, which they reported as helpful.

Tutor.com

The next resource offered by MCC, and thus the math instructors, was Tutor.com. This tutoring service is available 24 hours a day, so students can visit the website if their instructor is unavailable or if they have trouble understanding WebAssign. The students reported liking this website because it had live instructors and was available at all times. Students explained that some concepts were just not possible to understand even after the students received help from their instructors or WebAssign, and this site helped to explain such concepts. Both instructors stated that they liked Tutor.com because of the reporting feature of the platform. For example, if a student has a long session or seems especially confused, the platform sends a report to the college, which then sends a report to each instructor. This reporting feature allows the supplemental instructor to make decisions regarding which methods to use to help those students understand the concept(s) being taught. Rose, who lives off campus, explained that this tool was very helpful because she does not always have the ability to ask questions to the instructor during office hours. Sahel, who explained that he struggles with word problems, liked Tutor.com because it "explained in parts and details." This feature helped him to

understand exactly what the question was asking him to do. In sum, this additional technology helped the students to understand the material.

Communication

The fifth theme that emerged was communication. Specifically, both instructors discussed the importance of communicating with the students' on-level instructor. The math instructors have offices next to each other and are able to talk to one another almost every day. Liz stated the following: "We are all friends, so trying to find out schedules and how students are doing is easy." Lucy said the following: "I check on every student every 2 weeks that's in my supplement class." The instructors attempted to stay at the same pace in their course assignments so that they could effectively help the students who were also in supplemental classes. Instructors from supplemental math classes and on-level math classes shared schedules. Both instructors in this study reported that most students of different instructors are either exactly the same or within a day of matching the curriculum. This communication helps the supplement instructors to decide what to explain in class. In addition, it helps them to decide which methods to use to help the students. For example, if a student was struggling, then they would give that student more support through feedback and one-on-one time. The students reported receiving more feedback in supplemental class, which helps them with their understanding.

In addition to the importance of communication between instructors, the students talked about communication. Rose said the following: "I can stay after class and receive extra help." Andi echoed this statement by saying that she likes the ability to stay after class and to text or email the professor. In most of their email or text exchanges, the students obtained immediate feedback from the professor. Moreover, because many of

the students worked or had other commitments in extra-curricular activities, they could not always utilize office hours. Therefore, frequent and accessible communication was beneficial because it aligned with their schedules. Additionally, students mentioned that communication, both inside and outside of class time, allowed them to be more comfortable with the instructor.

Barriers

The instructors reported some barriers to students being successful, which was the sixth theme to emerge. Since COVID-19, the number of students who require supplemental classes has grown. The pandemic has also created even larger class sizes and the need to use the Zoom platform for class meetings. The following subthemes describe the barriers that were mentioned.

Class Size

Both instructors shared that sometimes the class size prevents them from reaching all students. The classes that I observed were not overly crowded; however, Liz said that her afternoon class has approximately 25 students. She explained, "this makes it hard to get to know students and help them when they need it in the classroom." Lucy stated that although her night class is small, learning about her students' needs was more difficult in larger daytime classes. Each instructor explained that effective relationships cannot be formed as effectively in a large class, and the instructor cannot offer as much one-on-one time.

Zoom

Since the pandemic, MCC has offered more classes online. In addition, instructors of traditional face-to-face classes are told to provide Zoom codes to students who become

ill with COVID-19 or cannot come to class. In addition to those students who are ill and cannot attend in person, MCC has begun to offer supplemental classes as O-Live courses to increase enrollment. In O-Live courses, the online students join the face-to-face supplemental classes at the scheduled class time on Zoom. The students must show their faces and workstations so the instructor can make sure they are paying attention to the material taught. Students in most online supplemental mathematics classes were working from home and the UD Center, which is a small building that MCC uses for Zoom classes. Traditionally, supplemental classes were taught face-to-face. However, the instructors explained that students being allowed to use Zoom makes classes more challenging. Liz stated the following: "I have to constantly remember to check on the Zoom students as well as the students who are in person." Liz explained that the Zoom students generally do not say much or ask questions; therefore, it is difficult to check their understanding of the curriculum. In my observations, both instructors attempted to involve the Zoom students by calling on them, asking about their days, and trying to build relationships.

Research Questions Answered

This section provides an overview of the findings related to each of the six research questions that guided this study.

Research Question 1

This section presents findings related to research question 1, which was as follows:

1. How does educational scaffolding in supplemental mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?

The supplemental classes were scaffolded to support student success. Scaffolding meant that the instructor was not always the dominant content expert. The students helped each other frequently. They reported that they felt more confident when they worked together and attempted to help their peers. Another dominant part of the class involved instructors repeating information or referring back to the material taught in the main course. Rose said, "I like how in the supplement class we repeat the information." Andi stated the following: "In the supplement class we go more in depth and go over things different ways which really helps." The students reported that going over the information again allowed them to acquire a deeper understanding of what they were learning in the on-level class. They felt that they were better able to ask questions in class, whereas in the on-level class they often felt intimidated. Asking questions allowed them to obtain an enhanced understanding of the material. Carrie said, "I feel comfortable in asking questions." In supplemental classes, the students also received more feedback from their instructor and peers. This additional feedback gave them more confidence because they felt that they were becoming more proficient in the material, which led to increased motivation to continue to improve and succeed. Many students reported feeling the most confident they had ever felt in math. They explained that increased confidence was one of their reasons for doing well.

Research Question 2

This section presents findings related to research question 2, which was as follows:

2. What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?

The instructors utilized online resources to help and monitor students. The students were able to use a wide variety of tools on WebAssign to acquire an improved understanding of the material. They were also able to use Tutor.com. Through Tutor.com, the instructors received reports on those sessions; these reports helped them to determine the areas where the students are lacking or need more help. As a result, the instructors could then provide further instruction on those topics.

In addition, the instructors communicated with each other on a frequent basis to learn about their students and the areas in which they need help. At MCC, the math offices are all in the same area, and the instructors are only separated by a cubicle-type wall. As Liz said, "all of us are great friends." The instructors frequently ask students how they are doing in their on-level class; however, they can also verify whether the students' perceptions are accurate by talking to each other. The supplement instructors also help by informing the on-level instructors what worked for the students in their class; thus, the on-level instructors can also implement those strategies. The instructors work brilliantly together, which helps them to provide students with new strategies and approaches in class.

Finally, the instructors also seek to build relationships with students. The students reported that their instructor cared about their success and that they knew they could ask questions in class through text messages or come for help during office hours. The

students also reported that the instructors cared about them as individuals and perceived the supplemental class to have a family atmosphere. These factors helped to create trust in class further boosting student confidence in their ability to complete the course successfully.

Research Question 3

This section presents findings related to research question 3, which was as follows:

3. What factors or teaching strategies used in supplemental mathematics do students credit for their eventual success in on-level mathematics courses?

The students identified several teaching strategies that helped them to achieve success in on-level mathematics. First, the students mentioned that it is helpful when the instructor goes over additional examples in class from the on-level class. They said that this practice sometimes makes them feel less confused about various concepts. Rose stated the following: "I like how the class is like a tutor class, where the information is repeated." Second, the students mentioned liking groupwork because they can receive help from their peers if they do not understand the material based on the instructor's explanation. The students reported gaining confidence in their supplemental class, which in turn helps them to gain confidence in performing in the on-level class. Several students reported creating study groups from the supplemental class to study for exams and complete homework. In Liz's class, the students reported developing "best friends" with whom to study the material outside of class. The students also credited the help that the instructor provides throughout the class. Carrie said, "she comes and helps us all the time." Furthermore, the students' ability to ask more questions helps them to understand

the material. Most mentioned how at ease they felt asking questions. Finally, the students felt that because of the confidence they gained, they could understand the material and were more likely to study outside of class, which helps them to achieve success in their on-level class.

Research Question 4

This section presents findings related to research question 4, which was as follows:

4. How do students describe the preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?

The students described the preparatory role in supplemental mathematics in similar ways to the strategies that instructors used to help them understand the material for their on-level class. For example, the fact that students were able to ask questions and gain confidence in the supplemental math class helped them to have confidence in their on-level class. Further, strategies utilized in the supplemental class was the repetition of information in similar and different ways than the on-level class. For example, the instructor went over concepts learned in the on-level course such as factoring but took more time to present a variety of methods and the students were able to practice those methods and ask questions with groups and the instructor. An additional strategy the students felt was beneficial was the groupwork and homework time, which created for a better understanding of the material in the on-level class. For example, the students did worksheets during groupwork that were similar to the problems on their on-level homework. The groupwork also helped students to develop study groups to study the on-level course material outside of class. Furthermore, the students praised the provision of

on-level homework time during classes. This allowed students to ask additional questions on confusing concepts. Hence, the supplemental class helped students become more comfortable and gain confidence in their ability to finish their homework independently as well as to perform well on quizzes and exams in their on-level class.

Research Question 5

This section presents findings related to research question 5, which was as follows:

5. How are the scaffolding techniques of cognitive structuring, questioning, feedback, instruction, and modeling utilized in these successful supplemental mathematics classrooms?

Cognitive structuring refers to the idea that individuals learn best when what they are currently learning builds upon what they already know. The instructors in supplemental math courses frequently reviewed older concepts so that students could have a foundation for future learning. For example, Lucy related the writing of a quadratic equation in vertex form back to the previous concepts of factoring and completing the square. In this way, Lucy was able to extend student's learning by reflecting on a concept that they already understood. Liz also provided opportunities for cognitive structuring when she explained the average rate of change and how to use a graphing calculator. The instructors also continued to simplify concepts for problems such as systems of equations. For example, Lucy separated the different ways to write systems of equations from word problems to solve systems of equations. The students also reported that the instructors continually reviewed the material from their on-level class. At times, the instructors explain the problems that were presented in on-level class work, while at other

times they put slight twists on the problems to test students' understanding of the material.

There were also different areas in which the instructors used structuring. During the further explanation session, instructors sometimes asked students one-word answers at the beginning and then progressed to why things happened by the end. For example, an instructor would ask a step in a mathematical process at the beginning such as what is the first step in solving the system by elimination. By the end of the class the instructor was asking "how do we know if we should solve a system with elimination or substitution?" The worksheets for Supplement to Math Functions were the same. They usually featured a few nonword problems at the beginning before progressing to real-life word problems, allowing students to gradually ease into the harder material and gain a deeper understanding.

Questioning was utilized in a variety of ways. The instructor asked questions in class to encourage students to articulate their understanding of course material. In this way, students were challenged to reflect on their learning, and the instructor could formatively assess student learning during class time. In addition, the students reported feeling as though they could ask questions. They asked questions to the instructor during the further explanation part of the class as well as to their peers and instructors during groupwork. Andi stated the following: "I feel like I can ask her anything and not feel bad." Students would sometimes stay after class to ask questions or text, email, or call their instructors. Overall, the students reported feeling less frustrated due to having the ability to ask questions to their peers and instructors.

The next area of scaffolding was feedback, which the instructors provided to students when they asked questions as well as when the students were performing groupwork. The feedback was both positive and negative. Students did not always complete worksheets or cards correctly; therefore, the instructors provided feedback and also worked with the students to achieve understanding. The students also received feedback when they sent texts, emails, or calls to their instructors. Most often, the content of this communication was clarification of concepts taught in class. Instructors responded quickly, so that students could advance in their understandings. Andi reported the following: "The professor would send us a response within a couple minutes up to a certain point." She went on to say that if it was too late at night, the professor would respond the next day. Finally, the instructors provided feedback on worksheets and after the students submitted them online. Students reported that the feedback on their worksheets was quick and received by the next class period.

Furthermore, the students also provided the instructor with feedback when they understood a concept (or did not). This was as simple as a nod of the head to indicate that they grasped the concept or a shake of the head and a look of terror to indicate the opposite. The students also provided verbal feedback if they did not understand something. The instructor then used this feedback to determine how to alter her instruction in class or how to more effectively help that student. Moreover, the students provided feedback to one another during groupwork and helped each other on worksheets, cards, and homework.

Additionally, the instructors used instruction to provide examples and explain different approaches to solving problems. An example occurred when one of the

instructors presented multiple ways to factor a quadratic. They also progressed their further explanations from easy to more difficult, providing students with different ways to understand the formulas. Moreover, students learned from their peers and instructors during groupwork sessions. Finally, the instructors continued to use multiple approaches, including one-on-one, homework time, and groupwork.

The final mode of educational scaffolding that I examined was modeling. In the classes, I noted that the supplement instructors provided several additional examples during further explanation, groupwork, and homework time. The students also modeled different examples when helping their peers during groupwork and homework. Sometimes, one group member took the lead and demonstrated how to solve a problem to other group members. Finally, the instructors demonstrated to students how to use additional resources on WebAssign and Tutor.com to help when students were not in class or did not have access to an instructor.

Research Question 6

This section presents findings related to research question 6, which was as follows:

6. What barriers exist that might prevent instructors from using educational scaffolding?

The COVID-19 pandemic created a need for much remediation, leading to large class sizes and the need for students to use Zoom when sick. Large class sizes prevent instructors from getting to know students as well as they could in smaller classes, which sometimes creates a disconnect between instructors and students. A large class size at MCC would be 20 or more students. The instructors also have greater difficulty walking

around the room when classrooms are crowded. The inability to move freely around the room prevented instructors from working with students one-on-one to provide further help.

Zoom is still being used to make courses O-Live as well as to increase enrollment to locations in rural areas. The reader may recall that O-Live courses provide an opportunity for a student to join via Zoom instead of attending classes in person. During classroom observations, it was evident that both instructors attempt to involve students on Zoom, but including those students is sometimes difficult. Instructors explained that sometimes the instructor does not know whether students are genuinely paying attention on Zoom. Lack of attention is often not evidenced until the student completes an exam. The students also reported feeling frustrated when they have less time with the instructor due to the instructor having to utilize their time for students on Zoom, instead of the students in person. However, MCC is now committed to offering supplemental classes as O-Live courses to reach students who cannot travel to a physical campus.

Summary of Research Questions, Findings, and Themes

Table 4.5 summarizes the findings and themes that supported each research question. These findings and themes were developed from the data collected through observations, interviews, and documents.

Table 4.5

Research Question Table

Research Question	**Findings**	**Themes**
1. How does educational scaffolding in supplemental	The instructors used scaffolding techniques to help students become independent learners.	Further Explanation Collaboration Additional Resources

mathematics courses support the success of students who are also enrolled in on-level mathematics courses at one community college in the Midwest?		
2. What additional strategies do supplemental teachers utilize to prepare students for success in on-level mathematics courses?	The instructors sought to build relationships with students, communicate with other instructors, and offer additional resources.	Relationships Communication Additional Resources
3. What factors or teaching strategies used in supplemental mathematics do students credit for their eventual success in on-level mathematics courses?	The students praised their instructors for the opportunities to practice working on additional problems, perform groupwork, and gain confidence.	Further Explanation Confidence Collaboration
4. How do students describe the preparatory role that supplemental mathematics played in their subsequent success in on-level mathematics courses?	The students liked the way the class was set up as well as the different parts, including further explanation, collaboration, and time to work on homework.	Further Explanation Collaboration Additional Resources
5. How are the scaffolding techniques of cognitive structuring, questioning, feedback,	The instructors used these techniques throughout the class by relating concepts, breaking things down, asking and answering questions, differentiating instruction, offering	Further Explanation Collaboration Additional Resources

instruction, and modeling utilized in these successful supplemental mathematics classrooms?	additional resources, and offering appropriate feedback.	
6. What barriers exist that might prevent instructors from using educational scaffolding?	The COVID-19 pandemic increased class sizes and made Zoom a necessity, which is hard on instructors and students.	Class Size Zoom

Summary

This chapter has presented findings from observations, documents, and interviews. The data collection and analysis helped me to obtain findings regarding how successful mathematics instructors prepared students in supplemental classes for their on-level classes. The instructors and students worked together to create an atmosphere that was conducive to learning. Furthermore, the instructors used educational scaffolding tools to prepare students and imbue them with the confidence required to study independently. The instructors also communicated with each other frequently to ensure that they could help students as effectively as possible. The feedback that the instructors obtained from students and other instructors helped to outline the material they should cover in class. The students knew that their instructors cared about them and wanted them to succeed. Next, Chapter 5 concludes the case study and discusses implications and recommendations based on the findings presented in the present chapter.

CHAPTER V

CONCLUSION

In this chapter, I discuss the findings of the study through the lens of the theoretical framework. I also discuss the implications of the study and present recommendations of how these instructors prepared their students in supplemental mathematics. The theoretical framework used in this study was the ZPD with educational scaffolding, which helped to direct the data collection and analysis of this case study. Because I followed a case study design, the reader is provided with an in-depth picture and analysis of how these successful mathematics instructors are preparing their students for on-level classes (Merriam, 1998). The thick description of data was created by collecting documents, performing interviews, and conducting observations.

Discussion of Findings

The following section will give an in-depth analysis of the results of the study through the lens of the theoretical framework.

Theoretical Framework

The purpose of this study was to explore, through the lens of Vygotsky's Zone of Proximal Development (ZPD) model, how successful instructors of supplemental mathematics courses at MCC prepare students for on-level mathematics coursework. The

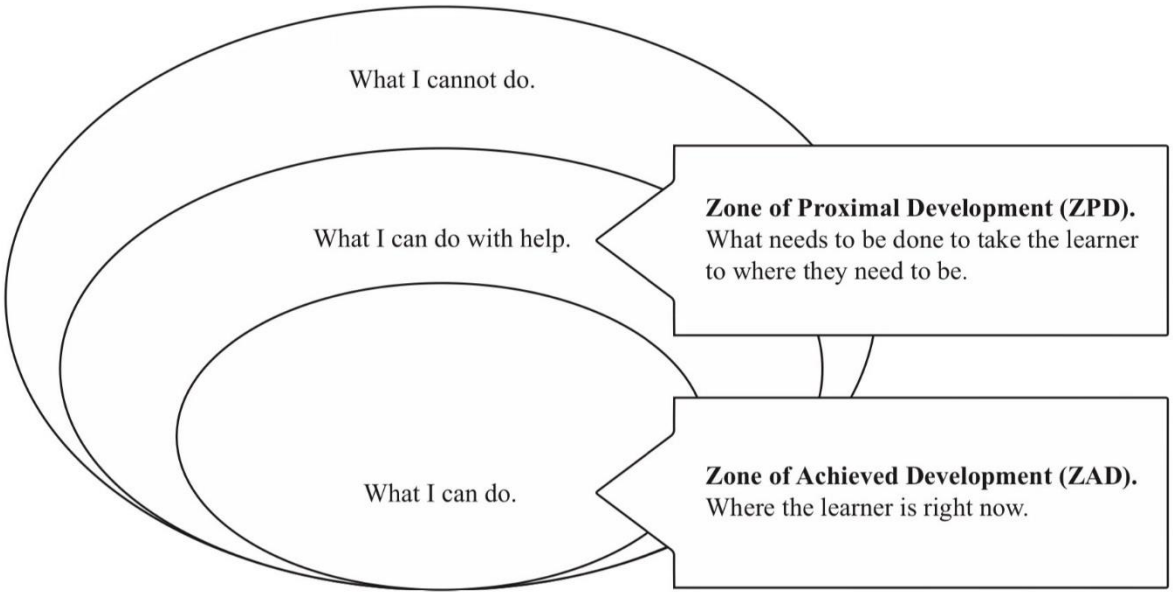
ZPD explains how the students navigate from being dependent to independent learners, while educational scaffolding explains the tools that can be used to gain independence. Since this theoretical framework was complex, I divided it into two subsections: The first presents the stages of the ZPD, while the second presents how educational scaffolding was used in this study.

Zone of Proximal Development

The first part of the theoretical framework was the different stages of the ZPD, which are illustrated in Figure 5.1. The transition from a dependent to independent learner was achieved through educational scaffolding techniques. These techniques are illustrated in Figure 5.2. There are three primary stages in the ZPD. This section describes the three stages as well as how students and instructors operated within them.

Figure 5.1

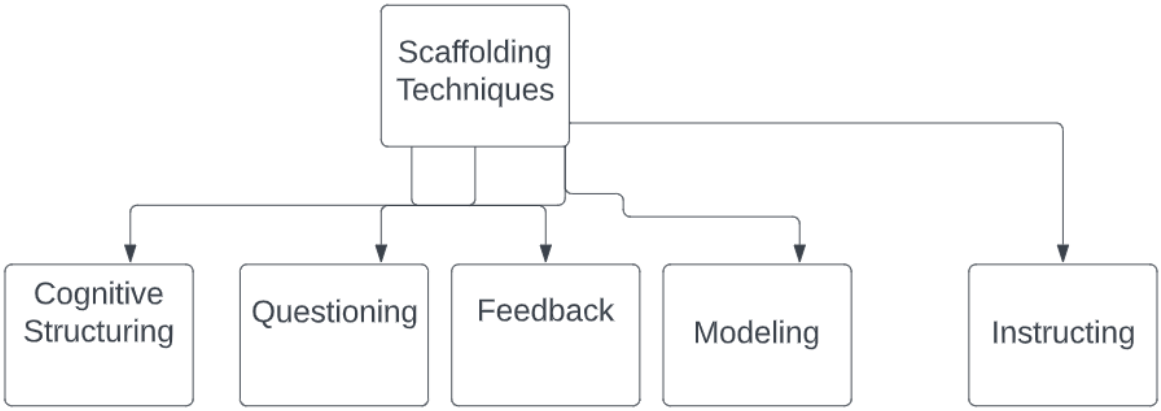
The Zone of Proximal Development



Note. Adapted from Khan (2017). *Mathematics proficiency of primary school students in Trinidad and Tobago*. Teachers College, Columbia University.

Figure 5.2

Scaffolding Techniques Used in Supplemental Classes



What I Cannot Do. Many students find themselves at this stage upon entering supplemental mathematics. As both instructors emphasized, students have often had one bad math teacher in the past who has negatively influenced their outlook on the subject. The students agreed that they did not always invest effort after such an experience; hence, there is much work that students cannot do, and they grow frustrated. During my observations, I noticed that there were students who struggled with the material. Both instructors responded by offering further explanations, groupwork where the students could collaborate, one-on-one time, and the ability to do some homework in class. The student interviewees all mentioned their instructors' methods. They did not always understand the material in the on-level class; however, in the supplemental class, the

material was presented to them in a variety of ways. These diverse explanations helped students grasp a better understanding of the course material. The techniques that the instructor used helped the students to reach the next stage of the ZPD.

What I Can Do With Help. In this stage, students are able to do their work but require the help of instructors, peers, or tutors. In this study, students received this type of help throughout the class from instructors and students when working on problems. During class time, instructors moved from student to student, answering questions and asking probing questions. As students' skills progressed, students were challenged to learn new, more challenging math concepts. Students did not work independently on new material. Instead, they worked in small groups and with the teacher's assistance. Sometimes, although the students reported seeking additional resources to help with the material, few reported that they used office hours to get help because the times often did not fit their schedule. However, the instructors made texting, email, and phone calls available to students. Many students also said that they were able to stay after class if they required extra help. Furthermore, the students used their peers and online resources more frequently and reported working with other peers in class to obtain help. The students also formed study groups to work with each other outside of class as well as used the tools on WebAssign to view examples or practice other versions to obtain help. Finally, they used Tutor.com to gain access to a live tutor to help them with their work. Thus, the students were clearly starting to motivate themselves to find help from resources to learn the material. This motivation leads students to the last stage of the ZPD.

What I Can Do. The final stage is called the Zone of Achieved Development (ZAD). In this stage, students have internalized the concepts and are ready to perform the problems independently. While observing and conducting interviews, I noticed that students were able to achieve the ZAD through confidence acquired from the methods used in and out of the class. This zone is reached at different times, as some students required more time to achieve comprehension and the confidence to work independently. In my observations, some students were able to work independently on certain concepts during groupwork, while others were independent by homework time. In the interviews, some students reported not being independent until closer to the exam, when they had time to review all of the information from the unit. Some students even reported feeling that they had learned the study skills required to succeed and were going to exit their supplemental class in the 12th week of the semester. Specifically, they had met the requirement of making an A or B in their on-level class and did not feel that the supplemental class would be necessary. This gaining of independence aligns with the many interpretations of the length of time it takes people to navigate from "What I can do with help" to "What I can do." These stages are navigated through using educational scaffolding, which is presented in the next section.

Educational Scaffolding

This final section of the theoretical framework provides an in-depth explanation of the theory of educational scaffolding and how it applies to this study. The theory of educational scaffolding suggests that students learn best when guided from dependence to independence in their learning (Van de Pol et al., 2015). This framework suggests that the appropriate supports of cognitive structuring, questioning, feedback, modeling and

instruction can be utilized to support student growth to independence. In this study, it was clear that educational scaffolding techniques were used to help students navigate through the ZPD. Figure 5.2 presented a visual of these techniques.

Furthermore, in this study educational scaffolding techniques were used as a bridge to advance from dependent to independent learning. Educational scaffolding suggests that learning occurs on a social and cultural basis. This means that the learning that is occurring in classrooms is done through a social process whereby the understanding of concepts is constructed by the learners. The results of this study aligned with educational scaffolding, that learning is a social process, and the understanding of concepts is constructed by learners.

Educational scaffolding suggests that learning is not an independent process, as this study emphasizes. In the supplemental classroom there is constant instructor-student and student-student interaction. The instructors in this study use the different educational scaffolding techniques to provide for that social interaction. For example. the instructors use different activities such as groupwork to encourage that social interaction among students. Furthermore, the instructors frequently helped students as a group and one-on-one to increase interaction.

The final basis of educational scaffolding is that a learner's understanding is constructed. In my observations, I noticed that instructors were constantly questioning students and then changing strategies based on students' understanding or lack of understanding. Furthermore, Lucy and Liz would constantly ask students if they needed concepts re-explained or explained using a different method. In addition, Lucy even gave

a worksheet out at midterm, Appendix G, that she describes as a way to better examine what a student needs and then use those suggestions to adapt in the classroom.

The students were also constructing their understanding of concepts when doing worksheets with their groupwork. The worksheets allowed the students to gain a better understanding through that social interaction. As a result of the social interactions, study groups formed among students. In my interviews some students talked about the study groups they had formed and how it had aided in their understanding of the on-level material. In these study groups students not only were learning through a social process but they were also constructing their understanding of the concepts. Henceforth, educational scaffolding provided a basis through which knowledge was socially and constructively understood.

Conclusions

The ZPD with educational scaffolding was a fitting framework for this study. It revealed the students' progress in math as well as the tools they used to transition from a dependent to an independent learner. The case study methodology has provided the reader with an in-depth view of the process in a supplemental mathematics classroom. Not only did it demonstrate how the instructors prepared students but also how the students navigated to become independent learners and perform well in their on-level math classes. The ways in which the instructors set up the classroom and used the time provided were also critical in preparing the students for on-level math.

Findings Compared to the Literature

This study aligned with the literature that was discussed in Chapter II. In Chapter II, the reader was immersed in the development of remedial mathematics education.

MCC completely redesigned their mathematics program to become a corequisite model like the other successful programs mentioned in the literature (Zaritsky & Toce, 2006; Jenkins et al., 2018; Royer & Baker, 2018). The literature also revealed factors that are understood as contributing to the success or lack of success in supplemental mathematics (Vorozhbit, 2012; Bowman, 2021). This study added to the literature by indicating there were more factors that contributed to student success or lack of success. Those additional factors revealed in this study included relationships, communication, and the accessibility of additional resources. Finally, in Chapter two we saw there were studies that used the ZPD as a theoretical framework to interpret student learning (Dibbs, 2014; Phelps, 2005). Findings from this study suggest MCC students navigated through the ZPD with educational scaffolding techniques to learn to work independently.

Implications

The following section discusses the implications for practice, research, and theory.

Implications for Practice

This study's findings have several implications for practice. It was evident in the findings of this study that the scaffolding techniques utilized by these instructors supported student learning as they progressed toward independence in mathematics at MCC. Although additional research is needed to understand how scaffolding supports student growth in different contexts, this finding suggests that scaffolding truly has value as a learning tool for students who are struggling at MCC. Another important implication for practice is that it was evident, in this study, that the instructors had utilized their training in ways that support student learning. This explanation is supported by the

finding that the instructional techniques of these two successful instructors were very similar. Therefore, these instructors utilized the training that they had received, and they worked collaboratively with each other and with instructors of on-level classrooms to support student success. This finding seems to suggest that collaboration and training across instructors may be an important component for success of these supplemental math classes at MCC (Zaritsky & Toce, 2006). Among existing instructors at MCC, my observations led me to conclude that much unstructured time exists at the beginning of the semester which these instructors seemed to use for enhanced professional development and collaboration. Working collaboratively, these instructors effectively utilized scaffolding techniques. In addition, MCC instructors are already required to participate in professional development once in fall and once in spring. The instructor is free to choose the type of professional development that meets his/her needs. Findings from this study suggest that supplemental instructors seemed to benefit when sessions on educational scaffolding techniques were provided.

Findings from this study further suggest that an emphasis on relationships between students, between instructors, and between instructors and students benefited students who were in remedial education at MCC. The students in these supplemental classes ranged in age and capabilities, a characteristic of remedial education that is fairly consistent across college campuses (Baime & Baum, 2016). The relationships that the instructors in this study worked to develop with students helped support the academic success of these students. These relationships seemed to support student confidence in their mathematics skills. Further, the students who attended supplemental classes in this study explained that they felt challenged by mathematics and often felt far removed from

understanding when they first come into class. In this study, educational scaffolding allowed MCC instructors to meet students "where they are" helping them to build confidence as they moved toward becoming independent learners.

Implications for Research

The first implication for research is the importance of relationships that were formed in the classroom. The supplemental instructors immediately started to foster relationships when students entered the classroom and then built those relationships throughout the semester. The instructors also attempted to develop student–student relationships through groupwork. Further research is needed to investigate the effects of such instructor–student and student–student relationships and how they assist students in progressing from dependent to independent learners.

This study also added to understandings in the literature by capturing student perceptions of the influence of scaffolding in their learning. Understanding instructional techniques from a college student's perspective provides insight into their growth and development as mathematics students. A potential area for future research is time. Some supplemental classes met twice a week, while others only met once a week. The instructors stated that they saw more success among those students who had their on-level class 3 days a week and their supplemental class the other 2 days of the week; thus, these students are receiving mathematics 5 out of 7 days a week. Understanding whether a significant difference, in fact, exists in success levels for supplemental students who have received math more days a week could help inform mathematics instruction for remedial students.

Implications for Theory

The ZPD with educational scaffolding was used to frame how successful supplemental instructors prepared their students for on-level mathematics. The theoretical framework was considered a delimitation. It affected the observations, interview questions, document collection, analysis of data, and results. The researcher used it to narrow the scope of the study.

Findings in this case study suggest that the instructors used a wide variety of scaffolding techniques to help students become successful in mathematics. Furthermore, the study's findings suggest that communication among instructors as well as instructor–student and student–student relationships were critical to student success. This study contributed to understandings in the literature by connecting the theoretical framework of the zone of proximal development (Sanders & Welk, 2005) to the instructional technique, educational scaffolding. Therefore, understandings of how movement of students from dependence to independence through educational scaffolding are expanded. Specifically, findings suggest that utilizing educational scaffolding as a strategy for increasing the success of students in supplemental mathematics helped to advance student progress through the zones of proximal development.

Recommendations

To conclude this study, some recommendations are provided for future research. These recommendations concern classroom techniques, professional development, and class size.

Classroom Techniques

Future research is needed to determine the length of time that instructors should spend on each activity and whether the length of time has any effect on student success.

Secondly, it would be interesting to determine whether applying these techniques to the on-level classroom would help the students enrolled not only in supplemental classes with their on-level class but also those students who only attend an on-level class.

Professional Development

The instructors in this study worked well together and followed similar strategies of educational scaffolding. Although this study did not address the topic of professional development, these instructors indicated that they utilized the training that they had received to work successfully with these students and promote their success. Additional research is needed to understand how professional development builds the capacity of instructors to utilize educational scaffolding. An additional area of research could be the influence of modeling, as a form of professional development, on implementing the techniques of educational scaffolding. Finally, this study captured the voice of students as they shared their perceptions of their educational progress and the instructional strategies that helped them succeed. Further research into how to train instructors to hear from the students may be a potential area of research.

Class Sizes and Instructional Format

Instructors in this study indicated that their effectiveness in working with students seemed to diminish as classes grew larger. Additional research is needed to understand optimal class sizes for supplemental instruction. When I observed and talked with the instructors, I found that they would be able to help more students and see more success if class sizes were smaller. Some classes currently exceed 20 students, especially in the fall. This is largely due to the financial state of the college and personnel available for teaching supplemental classes. I also found that students were appreciative of small class

sizes. The instructors often have large afternoon classes, in which it is difficult to build relationships and effectively use the educational scaffolding techniques. This area could be researched further through comparing the success rates of successful instructors in such classes with more than 20 students versus those with 20 or fewer, thus determining whether the class size played a role in the success of the students.

An additional finding was that these instructors felt less successful in working with students in online platforms such as zoom. Additional research is needed to understand this struggle and to investigate ways to support student learning through distance technology.

Summary

This chapter presented a discussion of the findings through the lens of the theoretical framework; the study's conclusions and implications; and lastly recommendations for future research. This study demonstrated the success of educational scaffolding in these supplemental mathematics classes and how its use was critical for student success. This study also noted the challenges in supplemental classes, such as students needing to use Zoom for various reasons and large class sizes in the fall.

This study was especially meaningful to me because my training as a mathematics teacher prepared me for a wide variety of students and ability levels; however, I had not observed many instructors before or witnessed how they use educational scaffolding techniques in their classroom. Moreover, I had not talked to many students about the techniques used in supplemental classes or how they helped their pathway to success. These findings help me understand the importance of educational scaffolding in these supplemental classes, and I consider it crucial to share these techniques with other

instructors. In this study, educational scaffolding served as a bridge that instructors utilized to assist these students in becoming independent learners.

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APPENDICES

Appendix A

Interview Questions Instructor

1. What is your goal for students in supplement? How do you go about achieving that goal?
2. What are some strategies you use in your classroom to help prepare students for on-level mathematics?
3. How do you asses student progress in supplement?
4. How do you know if a student has reached a point of being able to do their work by themselves?
5. What are the strengths and weaknesses of supplement?
6. How do these weaknesses act as barriers to teaching students?
7. How do you know if they are prepared for on-level mathematics?
8. What is your opinion of supplemental mathematics regarding its usefulness to prepare students to on-level mathematics?

Appendix B

Interview Questions Student

1. What do you do to prepare for supplement?

2. How would you describe a typical supplement class?

3. How would you describe the interaction with the instructor?

4. How does your instructor assess your progress in your supplement class?

5. How would you say supplement preparing you for your on-level math class?

6. What are the strengths and weaknesses of supplement?

7. How have these weaknesses affected you as a student?

8. What is your opinion of supplement?

Appendix C

Use the table below to answer questions 1-4.

X	0	5	10	15	20
f = f(x)	5.7	4.3	1.1	-3.6	-7.9

1. What is the value of f(0)?

2. What is the value of f(15)?

3. Calculate the average rate of change from x = 0 to x = 5. Use your answer to estimate the value of f(3).

4. Calculate the average rate of change from x = 15 to x = 20. Use your answer to estimate the value of f(19).

5. Suppose S(t) represent the average speed, in miles per hour, for a 100-mile trip that requires t hours. Explain why we expect S to have a limiting value.

Carbon-14 is a radioavtive substance that decays over time. One of its important uses is in dating relatively recent archeological events. In the following table, time t is measured in thousands of years, and C = C(t) is the amount, in grams of carbon-14 remaining.

t, thousands of yrs	0	5	10	15	20
C, grams remaining	5	2.73	1.49	.81	.44

6. What is the function and what is the variable?

7. What is the average yearly rate of change of carbon-14 dating during the first 5000 years?

8. Explain in practical terms the meaning of the average rate of change.

9. How many grams of carbon-14 would you expect to find after 1236 years?

10. What would you expect to be the limiting value of C?

Appendix D

1. $5x + 20$

2. $10x^2y + 6xy - 14xy^2$

3. $x^2 + 7x + 12$

4. $6x^2 + 25x + 4$

5. $3x^3 + x^2 + 6x + 2$

6. $x^2 - 9$

7. $x^3 - 8$

Appendix E

Oklahoma State University Institutional Review Board

Date:	08/04/2022
Application Number:	IRB-22-307
Proposal Title:	Supplemental Mathematics at a Midwestern Community College: A Qualitative Case Study
Principal Investigator:	C ourtney Miller
Co-Investigator(s):	
Faculty Adviser:	Kathy Curry
Project Coordinator:	
Research Assistant(s):	
Processed as:	Exempt
Exempt Category:	

Status Recommended by Reviewer(s): Approved

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in 45CFR46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which <u>continuing review is not required.</u> As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRB Manager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other

research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.

2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744- 3377 or irb@okstate.edu.

Sincerely,

Oklahoma State University IRB

Appendix F

Educational Leadership

CONSENT FORM

Supplemental Mathematics at a Midwestern Community College: A qualitative case study

Key Information

Study Purpose: The purpose of this study is to explore, through the lens of Vygotsky's Model of the Zone of Proximal Development, how successful instructors of supplemental mathematics courses in Northern Oklahoma College prepare students for on-level coursework.

Major Procedures of the Study: Qualitative case study that includes observations, interviews, and document collection. I will use purposeful criterion sampling to select teacher participants. I will identify two teachers who are perceived as successful in supplemental mathematics by asking the math department chair her recommendation for this study. Following identification of potential participants, I will contact two teachers by email. Following identification of teacher participants, I will ask the two participating teachers halfway through the course to identify up to six students who are making A, B, C, in the on-level course, have less than 16 hours within the last 20 years, and who have made significant progress in the class. From the list of students given to me, I will randomly select three students from each instructor to invite for participation. I will contact each of these students through email. I will also observe supplemental classes up to 4 times, up to 4 hours. Field notes will be taken. I will collect teacher preparation documents such as lessons, worksheets, and notes and nothing from the students.

Duration of Participation: one hour interview for instructors and students, up to 4 hours of observations for instructors and students, and 10-15 minutes for document collection from instructor.

Significant Risks: None

Potential Benefits: Helps identify successful teaching strategies and make instructors aware of practices such as educational scaffolding to help support student learning.

Compensation: 25 dollars at the conclusion of the interview

Background Information

You are invited to be in a research study of supplemental mathematics. You were selected as a possible participant because you have less than 16 college hours taken within the last 20 years, are enrolled in supplemental mathematics, and have made significant progress in your on-level math course. We ask that you read this form and ask any questions you may have before agreeing to be in the study. Your participation is entirely voluntary.

This study is being conducted by: Courtney Miller a doctoral student at Oklahoma State University

, under the direction of Dr. Kathy Curry in the Educational Leadership Department at Oklahoma State University.

Procedures

If you agree to be in this study, we would ask you to do the following things: Each student and instructor be interviewed for one hour by the researcher either over Zoom, Microsoft Teams, or in person. The students and instructors will be observed for up to 4 supplemental classes that will total up to 4 hours. Field notes will be taken. The instructor will be asked to give copies of documents they used to prepare the lesson. There is nothing else required of the student or instructor during this observation.

Participation in the study involves the following time commitment: One hour interview and up to 4 hours of observation for instructors and students.

Risks and Benefits of being in the Study

The study involves the following foreseeable risks: There are no known risks associated with this project, which are greater than those ordinarily encountered in daily life.

The benefits to participation are:

There are no direct benefits to you. More broadly, this study may help the researchers learn more about Supplemental mathematics teaching practices and may help future teachers and administrators become aware of practices such as educational scaffolding that successful teachers use in supplemental courses to effectively support student learning.

Compensation

You will receive a 25 dollar gift card as compensation for your participation. You will receive payment a 25 dollar gift card at the conclusion of the interview.

Confidentiality

The information that you give in the study will be handled confidentially. Your information will be assigned a code number/pseudonym. The list connecting your name to this code will be kept in a locked file. When the study is completed and the data have been analyzed, this list will be destroyed. Your name will not be used in any report.

We will collect your information through interviews. This information will be stored in a locked cabinet. When the study is completed and the data have been analyzed, the code list linking names to study numbers will be destroyed. This is expected to occur no later than one year. The audio/video recording will be transcribed. The recording will be deleted after the transcription is complete and verified. This process should take approximately one semester.
This informed consent form will be kept for 3 years after the study is complete, and then it will be destroyed. Your data collected as part of this research project, will not be used or distributed for future research studies.

It is unlikely, but possible, that others responsible for research oversight may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. We will only share your information if law or policy requires us to do so.

Voluntary Nature of the Study

Your participation in this research is voluntary. There is no penalty for refusal to participate, and you are free to withdraw your consent and participation in this project at any time. The alternative is to not participate. You can skip any questions that make you uncomfortable and can stop the interview/survey at any time. Your decision whether or not to participate in this study will not affect your grades in school.

Contacts and Questions

The Institutional Review Board (IRB) for the protection of human research participants at Oklahoma State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator at 405-589-9937, Courtney.a.miller@okstate.edu. If you have questions about your rights as a research volunteer or would simply like to speak with someone other than the research team about concerns regarding this study, please contact the IRB at (405) 744-3377 or irb@okstate.edu. All reports or correspondence will be kept confidential.

You will be given a copy of this information to keep for your records.

Statement of Consent

I have read the above information. I have had the opportunity to ask questions and have my questions answered. I consent to participate in the study.

Indicate Yes or No:
I give consent to be audiotaped during this study.
___Yes___No

I give consent to be videotaped during this study:
___Yes___No

I give consent to be contacted for follow-up in this study or future similar studies:
___Yes___No

Signature:_____ Date: _____

Signature of Investigator:_____ Date: _____

Appendix G

Algebra for Stem Midterm Progress Report

Current Grade:

What do you find is the hardest with your Algebra course? What has been some life saving tips that is allowing you to be successful in the course?

Discuss briefly this Supplement course. Has it been helpful? What is helping most? Is there anything else that you would like this course to provide to be more successful with your main course?

VITA

Courtney Ann Miller

Candidate for the Degree of

Doctor of Education

Dissertation: SUPPLEMENTAL MATHEMATICS AT MIDWESTERN COMMUNITY COLLEGE: A QUALITATIVE CASE

Major Field: Educational Leadership in School Administration

Biographical:

Education:

Completed the requirements for the Doctorate of Education in School Administration at Oklahoma State University, Stillwater, Oklahoma in May 2023

Completed the requirements for the Master of Science in Applied Mathematics at University of Central Oklahoma, Edmond, Oklahoma in May, 2011

Completed the requirements for the Bachelor of Arts in Mathematics at the University of Oklahoma, Norman Oklahoma, in December 2006

Experience:

Mathematics instructor at Midwestern Community College 2018-present

Mathematics instructor at Stillwater High School, Stillwater, OK 2014-2018

Mathematics instructor at Harding Charter Preparatory High School 2008-2014