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An Exploration of Scaffolding Strategies in a Remedial High School Mathematics Course

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MAT Mathematics, Kennesaw State University, 2012

MBA, Ambrose Alli University, Ekpoma, Nigeria, 2004

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Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

In a southeastern state school district, the educators understood little about the scaffolding practices of ninth-grade teachers of Foundations of Algebra (FOA), a remedial course. FOA is a mathematics course designed for students who need substantial help to master the required standards. An increasing number of students in 2 high schools failed FOA; hence, they were not prepared for Algebra 1. The purpose of this qualitative exploratory case study was to explore the scaffolding strategies used by FOA teachers. Bruner's constructivist theory and Vygotsky's zone of proximal development (ZPD) theory were used to guide this study. The research questions addressed how FOA teachers described their scaffolding strategies and how they scaffold their students' learning. Eleven high school mathematics teachers who taught FOA for at least one year volunteered and participated in the study. Interviews, observations, and document data were analyzed through deductive and inductive analysis using a priori, open, and axial coding strategies. This study's findings showed gaps in FOA teachers' knowledge and practices regarding the following scaffolding strategies: activating prior knowledge, manipulatives, visuals, teacher modeling, and technology. A 3-day professional development (PD) workshop was developed to address these gaps. Students, teachers, and administrators may benefit from the PD provided by school administrators. This project could contribute to positive social change when teachers improve and increase their scaffolding practices for students who ultimately increase learning and academic achievement.

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Dedication

Only God, my Maker, has brought me to this point in my life; He saved, delivered, and has been very patient with me. So, I dedicate this project study first and foremost to my Heavenly Father. Second, to my husband and love of my life, Mark, you encouraged me to pursue this degree. I remember you asking me years ago, “Don’t you want to add a Dr. to your name?” You encouraged me to begin this program because you believed that I could do it even when I thought I could not. Thank you for your unflinching support and determination to see me complete this program.

The firstborn of my late father, Paul Ogbeifun Ighalo, and Theresa Odion Ighalo, I was the first to earn a bachelor’s degree. I am also the first to receive a master’s and now to receive a Doctorate. I know my dad would have been very proud of my accomplishments. Mom, I thank you for your love and support. Third, to Mom and Dad Ighalo, I am so thankful for your daily prayers and love. Fourth, to my children and grandchildren, Steve, Matthania, Kayode, Oria, Joanna, and Tami; you are my joy.

Fifth, to my siblings, Dr. Andrews, Margaret, Josephine, Stella, Tommo, Deola, Patto, Biola, and Tonne. Sixth, to all my friends, colleagues, and mentors, thank you for pushing me and encouraging me. I want to particularly thank Dr. Victoria Landu-Adams, Dr. Marcela Jones, Dr. Tonya Richardson, and Juliet Ihedike, for your continued encouragement and support throughout this journey. I am grateful to God for every one of you, for you all indicate God’s mercy and favor in my life.

Acknowledgements

I thank God for seeing me through the past five and a half years to complete my doctoral journey successfully. I thank my family, colleagues, mentors, and friends for their love, support, and prayers. The attainment of this degree humbles me.

I want to express my inestimable gratitude to my very supportive committee, first to my Chair, Dr. Crissie Jameson. Her support, encouragement, and guidance were unwavering, next to my second committee member, Dr. Mary Howe, who profoundly influenced my doctoral journey. Next, I would like to thank my university research reviewer, Jeanne Sorrell, my Form and Style Reviewer, Nathan Sacks, and Dr. Steve Wells. He also helped supervise my work at the proposal stage of my doctoral journey and gave valuable advice and suggestions. I cannot thank you all enough for your guidance and professionalism. Lastly, I would like to thank all the teacher participants in my study, for, without you, I would not have any survey to investigate.

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Section 1: The Problem

The Local Problem

In a high school – school A, in the southeastern region of the United States, there was an increasing number of students failing their Foundations of Algebra (FOA) course and having to repeat the class. FOA is the first-year high school mathematics course option for students who completed middle school but still need substantial help in mastering the standards of grade levels 3 to 8. The purpose of this remedial mathematics course is to prepare ninth graders who struggle with mathematics to be successful in Algebra 1. This study addressed what was known about scaffolding practices by FOA teachers at two high schools, school A and school B. FOA course instructors are expected to incorporate varied instructional strategies, including scaffolding, to help students improve their foundational mathematics skills. Before the FOA course was launched in July 2015, teachers had training on how to use scaffolding as a strategy. However, no empirical investigation was conducted to understand the scaffolding practices of these teachers. Further, a lack of consistent training in scaffolding led to a concern on the part of decision-makers in the school district that FOA teachers have reverted to traditional teaching approaches (e.g., teacher-led lectures) that are not appropriate for this course.

The problem was that in a southeastern state school district, the educators understood little about the scaffolding practices of ninth-grade teachers of Foundations of Algebra (FOA), a remedial course. Although the school district educators understood little about the scaffolding practices used by FOA teachers, the then academic coach in school A indicated that teachers might be using a traditional lecture-based pedagogy. FOA, however, was intended by school leadership to be taught using a hands-on pedagogy in which instruction is scaffolded. The minimal knowledge by the school district educators of existing scaffolding practices created the quest to confirm that appropriate scaffolding practices were used to deliver the instruction to the FOA students for them to be successful in the course.

Studies have shown that scaffolding is an essential instructional strategy for meeting the needs of all students because of the positive impact it has on student learning especially low-achieving students (Belland, Walker, Kim, & Lefler, 2017). Scaffolding promotes student problem-solving and allows students to reflect on their work. Dale and Scherrer (2015) explained that appropriate scaffolding of instruction also facilitates deeper learning and lets students struggle with ideas that they otherwise could not resolve on their own.

State test scores of the comprehensive summative assessment of mathematics which provides information about how well students have mastered the state-adopted standards in mathematics and other core content areas from the 2016/2017 school year indicated some significant differences in School A. There are four achievement levels of this state summative assessment. Beginning learners (L1) do not yet demonstrate proficiency in the knowledge and skills necessary at the grade level/course of learning, as specified in the state's content standard. Developing learners (L2) demonstrate partial proficiency in the knowledge and skills necessary at the grade level/course of learning specified in the state's content standard. While proficient learners (L3) demonstrate proficiency and distinguished learners (L4) demonstrate advanced proficiency in the knowledge and skills necessary at the grade level/course of learning as specified in the state's content standard.

Of the total teachers at school A, four teachers taught FOA during the 2016/2017 school year. FOA Teacher A students had the lowest percent (17%) of beginning learners (L1). Sixty-nine percent of teacher A's students achieved a developing learner level (L2), and 14% were proficient learners (L3). Thirty-three percent of FOA teacher B's students achieved an L1, 44% were L2, and 22% were L3. While all the students of teacher C achieved L1 and teacher D had 39% of her students on L1, 49% were L2, and 12% were L3. Of these example teachers, teacher B taught FOA to students who were English language learners (ELLs), teacher C teacher had small group classes, and teacher D had inclusion classes (i.e., regular and special education students). These test results showed that teacher A had higher-performing students than the other teachers. The afore mentioned observation jump-started a quest to investigate the scaffolding strategies used by different teachers of the FOA course, identify scaffolding strategies that are frequently used by FOA teachers, and understand how FOA teachers scaffold the learning of FOA students. This study was conducted in two high schools, high school A, where I worked as a ninth-grade math teacher at the time of this study, and high school B; both in the same area and school district.

Problem in the Educational Discipline

Remedial mathematics courses in high schools had not been successful because of the way the courses had been taught. The purpose of remedial mathematics courses in high school is to prepare students to be successful in an Algebra 1 course, which is a fundamental step in higher-level high school mathematics courses. If a higher number of high school students graduate have all mathematics course requirements, then a smaller number of students will be enrolled in remedial mathematics classes during their college freshman year. However, there is a growing concern by mathematics college professors that 40% of freshman students enrolled in colleges in the United States are unprepared for college work, mostly in mathematics (Wheeler & Bray, 2017). In their study, Wheeler and Bray (2017), found that in the Birmingham, Alabama city school district, one of the lowest performing school districts in the state, 50% of its 2010 high school graduating class needed mathematics remediation in postsecondary settings. This is evident in the increasing number of students in the Alabama community and other community colleges in California that are required to take remedial mathematics. As in 2010, 60% of freshman students in community colleges were referred to remedial or developmental course work after a screening test as part of the entry level process. However, in states such as California, this number is more than 80%.

Many state governments exploit legislation as a tool to essentially reshape developmental education to improve student outcomes and reduce costs (Gewertz 2015). For instance, in the state of Wisconsin, assembly bill 56 was signed into law requiring the University of Wisconsin to report on any high school that sends six or more of its graduates to colleges who must take postsecondary remedial mathematics or remedial English courses. The reports were to be generated from incoming students' placement tests at the University of Wisconsin campuses. When taking any English or mathematics placement test that is an admission requirement, the university board shall require each student who is a graduate of a high school in the state to identify the high school and the city, village, or town in which the high school is located. Regardless of this bill, a question remains regarding why the students are not prepared for college classes. However, the law did not contain what actions may be taken against high schools that fall into that category (Gewertz 2015).

This issue of a growing number of high school graduates enrolling in college remedial courses has led to a bigger problem of over-placement of college students in remedial classes. In their study, Scott-Clayton and Rodriguez (2015) found that 72 out of 100,000 students at six institutions within an extensive, urban community college system (LUCCS) in New York were placed in remedial mathematics class after the initial screening test. Thus, little is known by the district educators about how high school mathematics teachers scaffold the learning of ninth-grade students; therefore, supporting the basis to investigate scaffolding strategies that will help prepare ninth grade mathematics students to be successful in Algebra 1.

Rationale

The problem was that an increasing number of FOA students were failing the course in school A; hence, they were not prepared for Algebra 1. In the first five years of the course in school A, 26.55% of students who enrolled for FOA failed the course, while

23.08% of students enrolled in FOA within the first five years failed FOA. The problem was widespread in the profession and appeared to be worsening. In the following paragraphs, I will expand upon the choice of this research problem.

This study was conducted in two high schools, school A and school B. For the first four years since the inception of the FOA course at school A, there was an increase in FOA students who failed the course and were thus not prepared for Algebra 1. In the 2015/16 school year, 32 out of 121 students (26.45%) failed FOA. In 2016/17, 47 out of 184 students (25.54%) failed FOA. In 2017/18, 62 out of 239 students (25.94%) failed FOA; in 2018/19, 95 out of 344 students (27.62%) failed the course. In 2019/2020, 68 out of 257 students (26.46%) failed FOA. In the first three years of the FOA course, students who failed FOA were placed in an online Algebra 1 class. These online Algebra 1 class students tended to perform below proficiency level since they had not yet grasped FOA standards. During the fourth year, the administration decided to create an FOA repeater class. However, some FOA teachers said the repeater class was an excellent replacement for the online Algebra 1 course. While in school B, from the inception of the FOA course, the students who failed the course were placed in FOA repeat classes. In the 2015/16 school year at school B, 43 out 99 students (43.43%) failed FOA, in 2016/17, 103 out 351 students (29.34%) failed FOA, in 2017/18, 140 out of 467 students (29.98%) failed FOA, in 2018/19, 57 out 415 (13.73%) students failed the course, and in 2019/2020, 53 out of 384 students (13.80%) failed FOA.

The second reason for this study's choice is that students failing Algebra remedial courses were a common occurrence in education in a secondary and post-secondary institution. A study that surveyed college mathematics faculty from public and private colleges and universities in 48 states, Er (2017) found that the faculty participants perceived that first-year college students had poor mathematical skills regarding what they considered essential topics for college preparation (reasoning and generalization). The faculty participants in this study also perceived that first-year college students needed some form of remediation to succeed in college courses. According to Butrymowicz (2017), in 44 states and in more than 200 two- and four-year colleges, more than half of the incoming students had to be enrolled in remedial mathematics and English courses. Based on these data, it is imperative that the district educators' understanding of scaffolding strategies and their use by high school remedial mathematics teachers be researched. According to the academic coach at high school A, FOA teachers scaffold their classroom management and assessments, but they do little scaffolding of their instruction. The purpose of this study, therefore, was to identify the scaffolding strategies used by FOA teachers and understand how FOA teachers scaffold FOA students' learning.

Definition of Terms

Constructivism: Constructivism is a learning theory believed to originally dating back to the times of Socrates, and later developed by three psychologists, Vygotsky, Piaget, and Bruner. The tenets of constructivism are that learners bring their own experiences into the classroom, and these experiences have a significant impact on students' views about how the world works. The teacher taps into students' prior knowledge and creates the opportunity for students to make sense of new content based on their previous experiences (Schulte, 1996).

Foundations of Algebra (FOA): The FOA course was developed by a southern state's Department of Education to help teachers address middle and elementary grade standards to rebuild the math foundations of students. The course requires scaffolding of instruction to develop algebra and numeracy in a variety of contexts including through number sense, proportional reasoning, quantitative reasoning with functions, and solving equations and inequalities.

*What I **K**now-What I **W**ant to Know-What I **L**earned (KWL) chart*: This is a graphic organizer that helps students organize information about what they already know, what they want to know, and what they have learned.

Ladder Method: This is a method used by mathematics teachers to teach prime factorization (finding which numbers multiply together to make the original number), the greatest common factor (GCF), and least common multiple (LCM).

Scaffolding: Scaffolding refers to temporary aids given to students during their learning process which eventually creates independence in the students (Malik, 2017).

Socratic Questioning: Socratic questioning is a scaffolding facilitation tool that involves asking low-level questions, recall type or closed questions, and high-level or open-ended questions that support critical thinking (Belland, 2017). Socratic questioning helps students develop critical thinking skills. Instead of telling students answers to their questions, teachers ask them leading questions that will help them think more deeply and leads to solutions.

Significance of the Study

The purpose of this exploratory case study was to identify scaffolding strategies used by FOA teachers and understand how these teachers scaffold learning for FOA students. The findings of this study may help various stakeholders, including students, parents, and teachers, to understand the instructional strategies used in the FOA course and how those may influence students' mathematics achievement. The findings of this study may also reveal immediate and long-term benefits of the FOA course for students and parents. FOA and Algebra 1 students can benefit from these findings because reflection regarding their instructional practices can result in improved instruction for these FOA teachers. According to Lee and Hannafin (2016), improved scaffolding is helpful to many mathematics students because it is linked to higher student self-efficacy in the subject. Lee and Hannafin (2016) presented a newly synthesized framework they named – 'Own it, Learn it, and Share it.' They integrated genuine autonomy, scaffolding, and authentic audiences into the framework to promote student engagement. Lee and Hannafin (2016) further explained that the design guideline for *Own it* encourages students to set personal goals and provide choices that matter. The *Learn it* piece is the scaffolding component of the framework. The *Learn it* design guideline provides step-by-step procedures on a given assignment to help students initiate and pursue any given assignment's goal(s). The approach also provides a guide to available tools and resources for any given project, think-aloud protocols. The *Share it* designs guideline enhances student engagement by sharing artifacts with other students - an authentic audience. As students share their products with other students, they deepen their understanding of the current concepts and gain a deeper understanding of different perspectives related to the artifact. Learners comprehend and are motivated to become better students and minimize their frustrations when scaffolding is used (Lee & Hannafin, 2016). Therefore, FOA students are more likely to meet instructional objectives than without scaffolding as they are more engaged in learning.

Royster et al. (2015) found that students overcome their initial fear of mathematics when the subject becomes real and accessible. When students can understand how mathematical concepts can be applied to real-life situations, they will begin to appreciate the use of mathematics, and their mathematics efficacy will grow. As students cultivate their self-efficacy in mathematics, they can start to see themselves taking higher-level mathematics classes like Precalculus and increase their aspirations for college enrollment (Bakker, Smit, & Wegerif, 2015; Pentimonti et al., 2017; Royster et al., 2015).

Parents may appreciate the findings of the proposed study because their children may earn five credits instead of four mathematics credits upon graduating from high school. Parents may see that their children benefit from an extra semester in the FOA class, which may increase their chances for admission in colleges upon graduation. Typically, students should have a minimum of four mathematics credits to graduate from high school. The state's department of education approved the FOA course as a credit course. Therefore, FOA students have the advantage of earning five mathematics credits by their senior year in high school. Secondly, parents will have access to resources that will help them in terms of everyday mathematics. Thus, parents will be motivated to be more involved in their child's learning. For example, a mathematics teacher can provide steps to solve specific mathematics problems through notes or videos on their class blog. Parents will be more open to helping, or at the very least, prompting their children to take advantage of teachers' resources.

Third, parents may enjoy the transformation they will observe in their children from the position of struggling with mathematics to becoming more successful. Every parent desires to see their child succeed and they also want their children to surpass their endeavors. Educating a child is like any other investment that is expected to yield favorable results. The growth, improvement, and development of students are the returns on the investment of education. The findings of this study may generate a deep understanding of the scaffolding practices of FOA instructors for the district educators.

Teachers may benefit from the proposed study results because those who teach FOA may take opportunities to engage in professional development (PD). PD for teachers can improve or validate their professional knowledge and cause them to be more confident in their teaching craft. Teachers may have more evidence-based scaffolding strategies for the FOA course due to this study's findings, and the two high schools of study, schools A and B, may benefit from improved teacher instruction, which will translate to more student achievement.

This study could be replicated in other schools in the district, and the entire school district may then benefit from the improved instruction across the district. There is a likelihood of higher college enrollment due to an increase in high school student achievement measured by high school graduation rates. Consistent, effective, and evidence-based scaffolding strategies used by all ninth-grade mathematics courses can improve student achievement as measured by the end of course (EOC) scores ultimately. Thus, when there is an increase or improvement in student achievement, such schools are on their way to becoming high-performing schools. As students enroll in the FOA course, this will lead to more success in terms of EOC scores, and there will be fewer FOA students repeating FOA or Algebra 1 courses.

Research Questions

The purpose of this study was to explore the scaffolding strategies used by FOA teachers and how those teachers use these strategies to scaffold FOA students' learning. This inquiry is characteristic of qualitative research which embodies understanding and making meaning of the experiences of FOA teachers. I used interviews, classroom observations, and lesson plans to collect data. Qualitative data were analyzed to answer the following research questions:

RQ1: How do FOA teachers describe their scaffolding strategies?

RQ2: How do mathematics teachers scaffold learning for FOA ninth grade students?

Review of the Literature

Conceptual Framework

The conceptual frameworks of this study were Bruner's constructivist theory and Vygotsky's zone of proximal development (ZPD). The first theory that framed this study was Bruner's constructivist theory. Learning is an active process rather than passive, in which the learner constructs new ideas based on current and prior knowledge (Bruner, 1973). The learner's understanding hinges on the dynamic dialogue between the instructor and the learner. The relevant constructs of this theory are social interactions, socratic questioning, and scaffolding.

Social interactions between students and teachers are relevant to the proposed study because student achievement is linked to improved social interaction. Juvova, Chudy, Neumeister, Plischke, and Kvintova (2015) found that there are four requirements for meaningful interactions between teachers and students during the learning process: motivation, respect of biological, psychological, and social particularities of the student, mastery of educational psychology, and working with failures. Teachers should motivate their students to be enthusiastic about learning and respect their students as human beings. Teachers without an extensive knowledge base of mathematics will not apply mathematical concepts to real-life situations and thus motivate their students.

Social interactions between students and teachers are fundamental to the learning process (Bruner, 1978). Bruner (1978) argued that social factors were essential to cognitive growth. The level of intellectual development depends on the extent to which instruction is given to the learner with practice experience. The presentation and the way the teacher explain concepts go a long way to determine how the learner can have a good understanding of the concepts taught. Hartmann, Angersbach, and Rummel (2015) said that social interaction involves the exchange of information between at least two individuals. Social interaction entails dialogue, which is a catalyst for acquiring knowledge. Dialogue as part of the active learning process happens not only between the student learner and the teacher but also among student learners usually in a group setting or in pairs. Social interaction enables individual learning as the learner assimilates new knowledge into old experiences, develops new perceptions, rethinks information that was misunderstood, and evaluates what is essential (Bada, 2015).

Socratic questioning is an essential strategy that constructivist educators use to assess their students' learning and plan new experiences for the learners. The application of Bruner's constructivist theory in the classroom can be evidenced by students articulating their prior knowledge when prompted by teachers' questioning and students summarizing concepts. The instructor asks guided questions that lead the learner to realize their thinking weaknesses and change their perceptions. The socratic method of instruction was created based on Socrates' idea that lecturing is not an efficient teaching method for every learner. Socratic questions are philosophical and deep, and they help improve cognition as this type of questioning triggers figurative thinking.

The third relevant construct of Bruner's theory of constructivism is scaffolding. Scaffolding is an enabling process for students to complete tasks or solve problems that they might otherwise not be able to accomplish. Communication is a vital part of scaffolding, and it supports students' developing expertise. Communication is the exchange of information between two or more people. One useful tool that is often used to communicate is dialogue. Bakker et al. (2015) said that one of the fundamental mechanisms that could make scaffolding productive is dialogue. In 2015, Bakker et al. 's study on scaffolding and dialogic teaching in mathematics showed that scaffolding and dialogic teaching both need to happen together to produce creativity or creative thinking minds in students. They argued that dialogic teaching is not one way but a two-way approach to instruction. They further explained the aim of dialogic teaching is not just for the student to know the right solution to a problem but for the student to be able to see any problem from their perspective, thus thinking creatively. They defined dialogue as a vibrant and meaningful discourse that is interactive between teachers and students and aligned with the lesson's content and addresses students' learning issues. Scaffolding provides metacognitive guidance from teachers to students regarding what tasks to do and what order to do them.

However, when a teacher 'tells' information to students, it is not considered a negation of scaffolding if it is contingent on the situation. During live interactions or dialogue between the teacher/tutor and the student/tutee, there is information that the teacher can pass on to the student that will allow for creativity on the part of the tutee. This happens when the student can think for him or herself and then eventually perform the task on his or her own. However, if the teacher gives too much information to the student who does not need to be creative or thinks further because of the teacher's information, that act is considered telling.

Closely related to the framework of Bruner’s constructivist theory is the ZPD developed by Vygotsky. The ZPD denotes differences between what a learner can do without any help or assistance and what he or she can achieve with guidance and encouragement from an expert or skilled partner. The term proximal refers to those skills that the learner is close to mastering (McLeod, 2012). Mediation based on verbal interactions between experts or teachers and learners or students and scaffolding of instruction are fundamental concepts in the ZPD. Scaffolding involves the teacher or expert modeling the desired learning task or strategy for the learner to perform under the guidance of the teacher, and after a gradual removal of the scaffold, the learner can complete the work independently. Vygotsky used the term collaboration as a means of assessing the ZPD. In a mathematics classroom, for instance, the teacher should identify students who have demonstrated mastery of specific mathematics standards and make them assist students who have a low capacity for mathematical proficiency. Figure 1 shows Vygotsky's ZPD and Figure 2 shows the relevant constructs of both theories. The constructs are meaningful social interactions between teachers and students, socratic questioning, scaffolding, and mediation based on verbal communication between teachers or skilled partners and students.

Figure 1. *Vygotsky's ZPD*

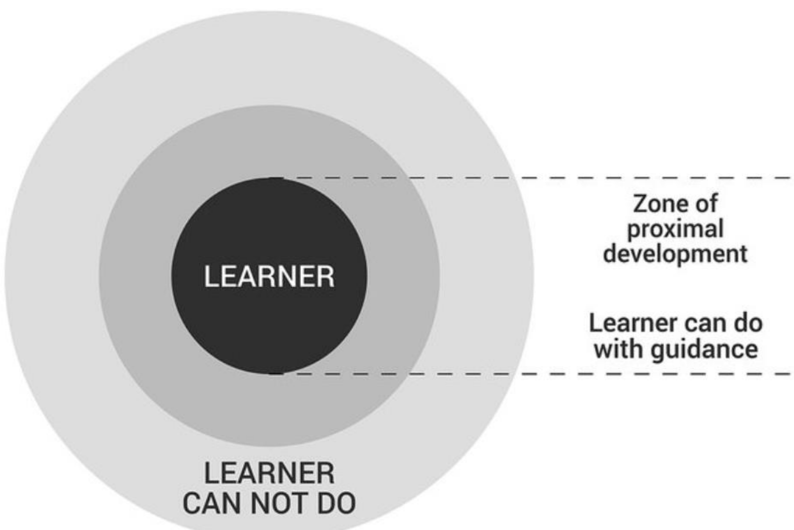
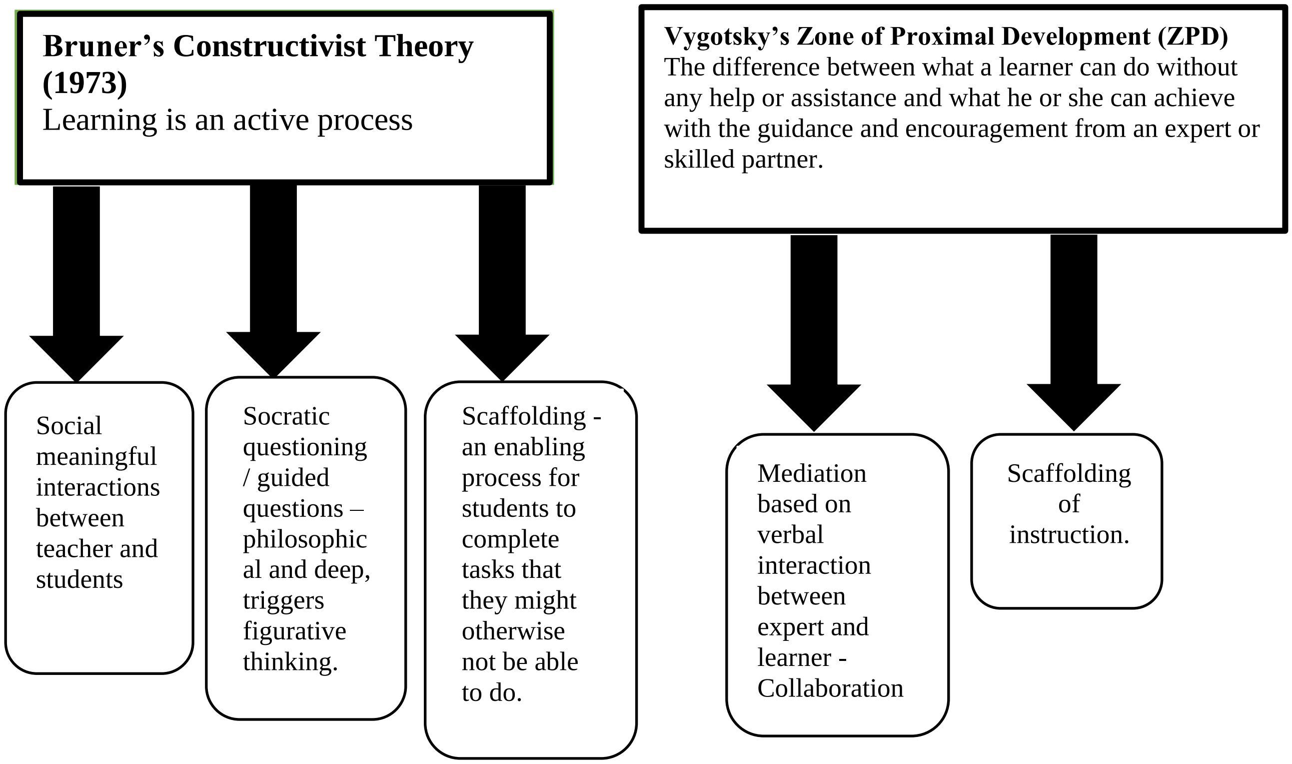


Figure 2. *Conceptual frameworks.*



How the framework relates to the research approach. Dewi and Harahap (2016) found that applying the theory of constructivism in an eighth-grade geometry class increased mathematical reasoning skills through cooperative learning jigsaw as measured by pretest and post-test results. In a study on the development of Geometry teaching materials based on constructivism to improve students' mathematic reasoning ability through cooperative learning jigsaw, Dewi and Harahap (2016) agreed with the argument of Menduo and Xaling (2010:114) that jigsaw strategy increases students' learning. The jigsaw strategy is less threatening for many students, increases student participation, reduces the need for students to compete amongst themselves, and reduces teacher dominance as it is student-centered. Jigsaw is a cooperative learning strategy where each student of a group focuses on aspects of a topic and becomes an expert on the topic assigned to the group.

The relevant constructs of Bruner's constructivist theory and Vygotsky's ZPD guided the purpose of my study which was to examine the scaffolding strategies of FOA teachers and understand how they use scaffolding techniques to support students' learning to prepare them for higher-level mathematics courses. The problem that was addressed in this study was that little was understood by district educators about the scaffolding practices used by FOA teachers at two high schools A and B in a southeastern state. In the first five years of the course in school A, 26.55% of students who enrolled for FOA failed the course, while 23.08% of students enrolled in FOA within the first five years failed FOA. Some students performed well in comparison to other students in terms of student achievement. Perhaps some FOA teachers were more skilled at scaffolding the learning of their students than other FOA teachers. I explored what scaffolding strategies or activities struggling students engaged in to make them successful. Teachers had different educational and social backgrounds and training which may be responsible for varied scaffolding types.

The conceptual frameworks, Bruner's constructivist theory and Vygotsky's ZDP, were used to guide data collection for this study. Interview and observation protocols were based on the relevant elements of both frameworks. I used the inductive approach to analyze my qualitative data, and this entailed *a priori* coding based on the constructs of both conceptual frameworks, open coding of a priori codes, and axial coding.

Review of the Broader Problem

The purpose of this literature review was to provide an analysis and synthesis of the broader problem related to the local problem and related literature. Using the online resources of Walden University, Internet searches, and Google Scholar, I searched the following education databases: Education Source, SAGE Journals, Science Direct, Taylor and Francis Online, Research Library, Psychology Data Base, ProQuest Central, EBSCO ebooks, Open Library, and Education Resources Information Center (ERIC). I also searched for dissertations via Dissertation and Theses at Walden University and Research Gate. I reviewed peer-reviewed journal articles, dissertations, reference materials, statistics, and data. I used a subject-based approach for my searches using keywords and combination search terms such as *remedial*, *developmental mathematics*, *instructional strategies*, *scaffolding*, *scaffolding* strategies, *professional learning*, *professional development*, *support*, *high school*, *motivation*, *principal*, *constructivist*, *algebra*, *gateway mathematics course*, and *administration*.

I organized the literature review according to themes by sorting existing research into the following categories: the importance of Algebra as the gateway to high school math, the significance of remedial courses, teachers' instructional strategies, PD, teacher implementation of new strategies, and support from administration. Although the mathematics course that is of the focus of this study is FOA, it was pertinent to include literature on the importance of Algebra in high school. The review of teachers' instructional strategies included the definition, the various strategies that abound, and the instructional strategies used in the mathematics classroom. PD is key to teachers' implementation of instructional strategies, and the application of it is anchored on the support teachers get from their administration.

Algebra

Algebra 1 is widely known as a gateway mathematics course in the high school curriculum. Eddy et al. (2015) found that algebra begins the pathway to college and career readiness. Algebra 1 is a gateway mathematics course because there are many instances where students are not successful in algebra and must retake it in college. Eddy et al. (2015) suggested unifying leading algebra standards and assessment frameworks to align the high schools and post-secondary institutions' algebra standards. The critical standards identified were variables, functions, patterns, modeling, technology, and multiple representations. According to Snipes and Finkelstein (2015), Algebra 1 is the basis for the more complex and higher-level mathematics courses, and ultimately, the catalyst for increased high school graduation rates. All high school students must have at least four credits in mathematics courses as part of graduation requirements. Typically, the first mathematics course for students coming into high school from middle school, assuming the student passed the state test in mathematics, is Algebra 1. The next mathematics course is Geometry, then Algebra 2. Students in their senior year of high school have the following options for the fourth mathematics course: AP Statistics, Mathematics of Industry and Government, Precalculus, Accelerated Precalculus, Advanced Finite Mathematics, Calculus, AP Calculus AB, AP Calculus BC, History of Mathematics, Multivariable Calculus, Engineering Calculus, and Advanced Mathematical Topics.

Achieving success in Algebra 1 creates opportunities for ninth-grade students. First, taking higher-level mathematics courses leads to taking college courses that involve mathematics and science. Many professional jobs such as electricians and engineers require a working knowledge of mathematics acquired through classes like Algebra, and a good understanding of this type of mathematics has helped provide more high paying and high-quality employment opportunities (Eddy et al., 2015). Secondly, the completion of higher-level mathematics courses like Algebra II increases students' chances of completing a four-year college degree program. Kim, Kim, DesJardins, and McCall (2015) found that completion of Algebra II increased students' likelihood of graduating from four-year colleges. Byun, Irvin, and Bell (2015) said that taking advanced mathematics courses had a significant and positive effect on mathematics achievement and college enrollment. Students who took a higher mathematics course in high school were more likely to be successful in college. Byun et al. (2015), however, found that the seemingly strong effects of taking advanced high school mathematics courses on college enrollment resulted from factors like the students' number of siblings, race, and students' prior mathematics ability.

Thirdly, not only is Algebra 1 fundamental to gaining access to higher-level mathematics courses in high school but also engaging in rigorous mathematics coursework during early high school grades helps to close the achievement gap among students of different ethnic and socioeconomic groups (Eddy et al., 2015). A student unsuccessful in Algebra 1 enrolls in college remedial mathematics classes typically, a growing concern in colleges. Showalter (2017) found that taking higher-level mathematics courses in high school reduces students' need to enroll in remedial mathematics classes in college. The value of the importance of Algebra as a gateway mathematics course in high school can, therefore, not be overemphasized.

Future benefits of advanced mathematics classes in high school. It is imperative that students are actively engaged in focused and purposeful learning with the help of highly qualified teachers who focus on problem-solving strategies, creativity, independent learning, and student reflection. Most companies in America outsource their jobs based on costs and skills available around the world. This situation has made jobs very competitive, and only the highly qualified individuals can have access to high paying jobs which require working knowledge of mathematics and science.

Remedial Courses

Remedial courses are generally courses designed to improve students' academic skills, usually in mathematics and English, and prepare them for the core class (Chen, 2016; De Paola & Scoppa, 2014). Remedial courses are delivered both in high school and in post-secondary education. Many remedial courses move slower or involve more hands-on learning than in regular classes to help support student success. The classes have different formats and are designed to reteach students who are not ready for steady work in the subject in question, such as preparing students in eighth and ninth grade or first-year college students for their core courses. Often, remedial classes are implemented during the summer to recover credits in various regular subjects (Allensworth, Michelman, Nomi, & Heppen, 2014). Others are designed to be intensified instruction during extended periods of class.

Remedial courses in high school mathematics. All the high schools in this study's school district offer the remedial mathematics course to ninth-grade students. Martinez, Bragelman, and Stoelinga (2016) found remedial courses to be beneficial to the students enrolled in such classes regarding their academic achievement. For instance, the Intensified Algebra 1 (IA) program adopted by some schools in Illinois and Texas, like the FOA course, was designed to help underprepared students from middle school and build a solid foundation of mathematical concepts in Algebra 1. What distinguished the IA class from other regular Algebra classes was that it was first offered as extended periods of class time or double periods.

Secondly, during the IA period, the student participants worked in groups collaboratively on discovery projects, focused on conceptual development, rigorous and high cognitive demand tasks (Martinez, Bragelman, & Stoelinga, 2016). The IA program provided some foundational support structures. Among such support structures were well defined daily learning routines, graphic organizers to help students' mathematical thinking, visual animations, and representations in daily lessons. Every day, teachers addressed the new skills needed for further learning and ensured students practiced every day and reviewed students' work daily to correct any misconceptions. The IA program yielded the desired results as the results of pre- and post-tests of the IA course showed that student participants improved in their knowledge of Algebra.

The concept of double-period classes was adopted in some other states around the country like in North Carolina and cities like Chicago and was labeled double dose for remedial mathematics programs (Henry, Barrett, & Marder, 2016). Double dose meant taking two class periods of mathematics, so students spend more time in the mathematics class. In a North Carolina school district, teachers used the double-dosing program for remediation, maintenance, and mathematics skills enrichment. High school students who received a double dose for remediation had the lowest incoming test score and the highest achievement levels and demonstrated the importance of consistent implementation of teachers to make the program successful (Henry et al., 2016).

Many high schools around the country have recorded successes with their remedial mathematics programs. Some of these remedial mathematics programs are targeted for 8th graders as they transition to high school like the Elevate Math in California, while other remedial programs are designed for 9th graders like the one conducted in the Chicago public school system. The summer credit recovery program was designed to provide an opportunity to ninth graders who failed Algebra 1 to recover credit in Algebra 1 during the summer before moving on to the next mathematics class, Geometry. Funding was provided to participating schools to hire teachers to teach Algebra 1 credit recovery courses during 2011 and 2012 summer. The implementation of the recovery program doubled the recovery rate, although the percentage of students who recovered credit in Algebra 1 was still low (Allensworth et al., 2014).

Remedial courses in other high school subject areas. Although this study's focus is on a remedial mathematics course, other subject areas show similar results in how remedial courses can be beneficial for students. There is limited literature regarding remedial high school courses other than mathematics. Luoch (2014) found that the remedial English course 0999 raised the English proficiency of 46 freshmen students at the United States International University in Kenya as there were significant changes between the students' pretest (placement test) and post-test (the same placement test), which were an improvement on the students' performance. Just like Algebra 1 is a gateway mathematics course in high school, the subject of reading is also a gateway skill by which students access educational opportunities. Reading is a gateway to academic success. According to Wilkerson, Yan, Perzigian, and Cakiroglu (2016), a significant step in addressing poor reading levels in high school involves identifying students who need remedial reading instruction. The reading remediation instruction usually targets one or more reading areas, for example, reading and comprehension.

Teachers’ Instructional Strategies

High-quality teacher instruction is the core of effective schooling (Early et al., 2016) and is crucial for the success of any remedial course, such as FOA. Instructional strategies are techniques that teachers use to teach students to become independent and strategic learners. These techniques become learning strategies that students use to take ownership of their learning. When students can select and use appropriate learning strategies at any point in time, one can then conclude that the teachers’ teaching strategies were effective. Instructional strategies help students to focus with attention on the concept that they are learning, motivate them, help students to organize, retain information, and use them as and when needed. Instructional strategies can also help students to develop confidence in their mathematics skills, reasoning, and mathematical talk. Students are then able to reflect on and monitor their learning.

Studies (Argün & Emre-Akdoğan, 2016; Augustine et al., 2015; Dudek, Lekwa, & Reddy, 2017; Early et al., 2016; Star, 2015) have shown that standards-based that is rigorous in content and teaching methods help to improve standardized test scores. Standards-based instruction include strategies that use physical and virtual manipulatives, questioning, examining, engaging, exploring, developing new insights, breaking down concepts, and allowing students to answer their questions. Other strategies are designed to enable students to conduct their experiments, analyze their results individually or in a group setting and draw their conclusions (Gningue, Menil, & Fuchs, 2014; Emre-Akdoğan & Argün, 2016). Scaffolding in a group setting is useful for student learning. The quality of the interactions among students within a group shapes their learning (Van de Pol, Mercer & Volman, 2019). Successful cooperative learning and student collaboration are only possible when a teacher provides a positive learning environment. Teacher-student interactions that are positive and have mutual respect embedded in them are essential in a positive learning environment.

Students take ownership of their education in the ideal mathematics class, constructing new learning based on current and prior knowledge (David, 2017). The teaching strategies that should characterize a mathematics class must include an instruction that aligns with the state's standards and curriculum. Teaching mathematics should also involve rigor that keeps students challenged to thinking creatively about problem-solving and select appropriate problem-solving methods. According to Belland (2017), the productive struggle is the high highlight of scaffolding instruction, and productive learning results from the productive effort. The productive struggle time is that point that students transition to become independent learners. Therefore, teachers should ensure that the struggle time is productive and not overwhelming for the student. Teachers then allow students to struggle through challenging tasks before assisting them. Productive struggle is when students put in their effort into learning, which produces grit and creative problem-solving. Engaging in this process helps students take ownership of their learning as they connect each struggle experience to concepts learned.

Another essential teaching strategy that is especially useful for students needing extra support is scaffolding and dialogic teaching (Bakker et al., 2015). There are three parts of scaffolding: diagnostic, responding to results, and summative assessment. In the first part, the teacher wants to know what the students know about a topic. The teacher can do this by giving a pre-test or any other type of formative assessment. The second part of scaffolding is that the teacher responds to the diagnostic assessment results by giving formative assessments on the fly or via planned classwork or homework. The third part of scaffolding is the summative assessment. The goal of this teaching strategy is to assist students in becoming independent thinkers. Dialogic teaching involves open-ended learning dialogues, showing respect for students' views no matter how wrong they appear to be, being open to taking on new perspectives, pausing to allow students to respond to teachers' questions (Bakker et al., 2015).

Professional Development

The ultimate objective or goal of teachers' PD is to increase student achievement by improving teacher quality (Fischer et al., 2016; Nolan & Molla, 2017). The importance of teachers' PD cannot be overemphasized, especially for teachers who teach struggling students. PD focused on specific teaching practices increases the use of those practices in the classroom, thus making the teachers more effective (Whitworth & Chiu, 2015). It is essential first to find ways to motivate the students and help them change their mindsets from a fixed to a growth mindset. Among other factors, teachers' participation in PD is associated with students' performance. It is one thing for teachers to take care of students and have a passion for students' learning, and it is another for teachers to use innovative and effective teaching strategies to consider the standards and concepts needed to promote and provoke independent learning among students (Abrami et al., 2015). The more teachers' expertise, the more they are likely to engage in high quality-instruction using evidence-based teaching practices (Fischer et al., 2016). Examples of evidence-based practices include determining common patterns of students' thinking, facilitating classroom discourse, overseeing student-led projects and small groups, managing the dynamics of students' complicated social relationships, and selecting and sequencing students' work to be presented to facilitate connection-making between mathematical ideas (Averill, Drake, Anderson, & Anthony, 2016).

One crucial issue to consider when looking at PD for teachers is professional capital. There are three aspects of professional capital, namely: human (content knowledge), social (access to continuing support and collaboration), and decisional (making decisions in many complex situations and cases). The possession and interplay of these three elements enhance the performance of teachers. The ownership of the power of professional capital means that teachers are smart, talented, committed, and relentless in their expert-driven way to serve their students and their professional learning communities and they always strive to improve their teaching performance. Professional confidence is an essential element of professional capital, which is at the center of teacher professionalism. As a teacher increases his or her professional capital, the teacher will be more confident in putting professional capital elements into practice (Nolan & Molla, 2016). The most effective type of PD is the mentoring of teachers. The attitude of teachers during the mentoring process is key to the positive transformation of the teacher mentee. The teacher mentee must be positive through the mentoring program to be open to accepting corrections, new ideas, and practices, and strive for the best learning outcomes for students (Nolan & Molla, 2016). This issue leads to the next topic of teacher implementation of new strategies.

Teacher Implementation of New Strategies

Implementing evidence-based classroom strategies is very vital to a teacher's success. When teachers' attitudes change due to intrinsic and extrinsic motivational factors, they will be willing to try new strategies to improve their content knowledge and pedagogies. PD, in whatever form it takes, should form an integral part of a teacher's professional growth. Teachers must have the right attitude towards learning and be willing to implement new practices to improve student achievement. The knowledge gained during PD will be lost if teacher learning is not followed up with support from teacher leaders and administrators and follow-up training sessions. Tam (2015) found that professional learning communities (PLCs), a PD model, help nurture teacher learning and growth. The collaboration of teachers makes the PLC more effective and can change teachers' beliefs, attitudes, and practices.

There are some actions that teachers can take to ensure that they implement the instructional strategies they learn at PD sessions—for instance, using a multi-media, CAP-TV, for recording content knowledge and modeling best practices for teaching strategies. Some studies have shown that using multi-media helps to equip teachers with knowledge and skills to improve the quality of and implement evidence-based classroom management practices (Kennedy, 2016). Kennedy (2016) found that using multi-media for professional learning is an effective way to ensure that evidence-based classroom management and instructional strategies are implemented in classrooms.

Support from Administration

School principals provide strategic leadership and promote students' learning and achievement by supporting teachers' learning and monitoring teachers' professional growth. The principals' role is shifting from managing schools to supporting the development and improvement of teachers' instructional strategies. However, for principals to provide the needed support, they need to have more than content knowledge of courses that are taught; they also need to have an adequate understanding of the effective research-based pedagogy (Boston, Gibbons, Henrick, et al., 2017; Johnson, Otten, Steele, et al., 2015). Teachers' education and instruction are based on research, making it imperative for any principal to have a basic knowledge of research-based pedagogy.

Administrators must consider how effective a high school mathematics teacher is in his or her classroom including teachers’ self-efficacy about teaching a subject, students, and the atmosphere in the school. School leadership sets the tone of the atmosphere in the school by implementing the desired culture. A school culture and an administration contribute to a teacher's motivation or amotivation. When teachers are motivated, whether intrinsically or extrinsically, it transfers to his or her students. Han, Yin, and Boylan (2016) found that teacher motivation is a crucial determination of student motivation and teacher effectiveness. When teachers experience amotivation, they lack the intention to engage in instructing their students and the caring about their students' performance.

Effective teachers are usually intrinsically motivated to use their students' data to make pedagogical decisions that will improve students' achievement (Vanlommel, Vanhoof, & Petegem, 2016). However, it is crucial for the school administration to provide supportive relationships that will motivate teachers to use data in their decision making. The more an administrative team is convinced of the importance of reflections based on data and willing to critically review their performance based on data, the more teachers will be motivated to use data to make decisions on their classroom, instruction, and assessments.

Effective teachers also need the support of the parents of their students. Good teachers usually communicate very often with the parents or guardian of their students because what goes on in the homes of the students has a direct impact on student's performance at school (Bhargava & Witherspoon, 2015). Home-based parental involvement influences the effective implementation of some instructional strategies; for instance, parents ensuring that their children are engaged in various forms of homework practice.

Implications

Every teacher in the field of education brings his or her style of instruction based on personality to the classroom. However, when the scaffolding strategies that are used by all teachers who teach FOA are effective and consistent across the entire school district, the gains for the students may be considerably higher than the current situation. It was hoped that potential findings of this research would include that some of the teachers had yet to practice recommended research-based scaffolding strategies. I proposed a PD program on scaffolding to the school district as continuous training to all FOA teachers based on the findings of this research.

Summary

The findings of this research showed the various scaffolding strategies used by teachers who teach ninth grade FOA. This remedial course was designed to help bridge the learning gaps of the ninth-grade students from middle school and prepare them for Algebra 1. Investigating whether teachers were using a lecture-base format instead of the concrete, foundational base of mathematics was a rationale for this study. FOA teachers were expected to use scaffolding techniques and manipulatives since FOA is a remedial course. The study was conducted in two high schools in a school district located in one of the southeastern states of the United States. This section contains relevant literature on remedial courses, remedial mathematics courses, teachers' instructional strategies including scaffolding, PD, teacher implementation of new approaches, and support that teachers receive from administration. Section 2 includes the research design, participants of the study, the process of data collection, and how data were analyzed.

Section 2: The Methodology

Research Design and Approach

The problem was that the school district educators understood little about the scaffolding practices used by FOA teachers. This qualitative case study involved investigating FOA teachers' scaffolding strategies in two high schools in a southeastern state and how they scaffold learning for FOA students through a constructivist lens. This section contains the research design, participants, procedures to collect data, and data analysis. This section also includes descriptions of measures taken to ensure teacher participants' ethical treatment and procedures to address the accuracy and credibility of research findings and interpretations. The two research questions that guided this study are:

RQ1: How do FOA teachers describe their scaffolding strategies?

RQ2: How do mathematics teachers scaffold learning for FOA ninth grade students?

Research Tradition and Rationale for Chosen Tradition

I decided to adopt a case study method as the research design based on the problem and research questions. According to Yin (2015), case studies are more relevant in answering how or why questions involving some present circumstance or social phenomenon. Case studies explain, describe, enlighten, and illustrate a situation or a case (Yin, 2015). Researchers use case studies, whether quantitative or qualitative, for exploratory, descriptive, and explanatory studies (Nardi, 2005). A qualitative exploratory case study approach and methodology were selected to better understand the scaffolding strategies of FOA teachers and how they helped the learning of ninth graders in the FOA course. Typically, qualitative research methodology is naturalistic: the researcher goes to the site of the action studied to carefully observe the phenomenon and asks participants broad questions for a better understanding of the action. The information gathered is then reported as accurate, realistic, and convincing. In a quantitative study, the researcher collects numeric data from many people and analyzes trends using statistical analysis (Creswell, 2012).

In a qualitative case study, the researcher explores units of analysis via in-depth data from sources such as close observations, interviews, documents, and reports. After the researcher has bound the case of study, determining the theoretical propositions is the next step in designing a case study. Theoretical propositions or theories help the researcher generalize lessons from case studies (Yin, 2014). There are many types of qualitative study approaches. Four of these approaches are narratives, phenomenology, grounded theory, and ethnography. A qualitative case study was considered most appropriate for this study instead of other qualitative types like ethnography, grounded theory, narrative, and phenomenology.

Ethnography. Ethnographic research involves the researcher as a participant-observer immersing him or herself in the site to produce a detailed cultural description and interpretation of the phenomenon under study. According to Merriam (2009), immersion in the site is the primary method of data collection in addition to interviews, documents, records, artifacts, and diaries of daily happenings, personal feelings, ideas, impressions, or insights with regards to those events. Case studies like ethnographies can take a long time to complete the research, but they differ in terms of the case in the study's focus. Case studies may involve focusing on a program, event, or activity involving individuals rather than groups. Ethnographies involve concentrating on a group of people to identify shared patterns of behavior or cultural themes. This study was not related to cultural analysis; hence, ethnography was not an appropriate research design.

Grounded theory. Qualitative researchers use grounded theory research design to generate a theory to explain a process, action, or interaction about a substantive topic (Creswell, 2012). In grounded theory, the data collected provides a better explanation of the study than a borrowed theory. This study examined the scaffolding strategies used by teachers that teach a remedial mathematics course. I used Bruner's constructivist theory of learning and the ZPD developed by Vygotsky as the conceptual framework for this study. Scaffolding is a central construct of this research's conceptual frameworks; both theories have much applicability to this study. Therefore, the grounded theory design was not an appropriate research design for this study.

Narrative. Narratives are stories involving peoples' personal experiences. This research design type involves collecting data from individuals via stories about their lives and writing narratives about their experiences. The narrative analysis involves focusing on the microanalytic picture or individual stories. According to Wang (2017), the narrative inquiry approach to qualitative research is an approach involving the study of human lives to honor lived experiences as a source of valuable knowledge and understanding. The research questions that a narrative inquiry provides answers to are questions of What is true? What exists? What is real? These were not the type of questions that guided this research. Also, I was not seeking to honor the experiences of the proposed participants of this study. Hence, the narrative inquiry approach was not an appropriate design for this study.

Phenomenology. This research design involves focusing on the lived experiences, everyday lives, and social actions of individual participants. The participants in a phenomenological study must have a set of shared experiences which are bracketed, analyzed, and compared to identify the essences of a phenomenon. The phenomenologist must therefore use purposeful sampling or recruitment through ads, groups, or professionals to select the study sample. Since my study sought to examine and understand the various scaffolding strategies used by FOA teachers and did not involve assuming FOA teachers use the same pedagogy, this research design was therefore not appropriate for this study.

Participants

Study Participants

This study was conducted in two high schools in the second-largest school system located in the southeastern part of the United States. At the time of this study, the district was the 23rd largest in the nation, a suburban district that currently serves nearly 113,000 students with 112 schools including 16 high schools and over 18,000 employees. Teachers who had at least a year of experience teaching FOA or were teaching FOA at the time of this study were potential participants. Some teachers taught ninth grade Algebra 1 only and not FOA; those teachers were not included in this study. I identified all teachers who were eligible to participate in my study. Of the 17 eligible teachers in both schools A and B, 15 of them responded. Thirteen of them responded positively, and two of them declined for personal reasons. Of the 13 teachers, I observed 11 of them before schools in the district were locked down due to the pandemic. Of the remaining 11 teachers, seven taught at School A, and four taught at School B. Two of the seven teacher participants taught FOA and Algebra 1 in the year prior to this study and were not teaching these courses at the time of this study. I only interviewed them; therefore, I did not observe their classes. In the two target research sites, 11 mathematics teachers participated in the study. This type of observational case study required collecting data from persons directly associated with the case, which were FOA teachers. Since there were 11 participants, the level of inquiry was thorough in terms of obtaining well-collected qualitative data.

A purposeful sampling strategy was used to select the participants who could provide rich, dense, and focused information on the research questions that allowed me to investigate the phenomenon. Gentles, Charles, Ploeg, and McKibbon (2015) stated that whenever qualitative researchers state purposeful sampling as their sampling strategy, they must describe what it means in its specific context. Therefore, this study's sampling strategy was homogenous sampling, which involves sampling individuals based on membership in a subgroup with defining characteristics (Creswell, 2015). To begin purposeful sampling, the researcher must first determine the inclusion criteria for selecting the participants or a list of essential attributes. This criterion not only reflected the purpose of the research but also guided the researcher to identify information-rich cases. The cases must be obvious to give the researcher enough information to answer the research questions (Merriam, 2009). All the participants were either FOA teachers or had taught FOA in the past year.

Eleven participants were used for the current study. According to Merriam (2009), the adequate number of participants in any qualitative research depends on their questions. In a similar qualitative study, Harris, Silver, Macinko, and Weisberger (2015) utilized 11 participants who were purposefully selected. All 11 participants were interviewed, which provided a detailed description of the findings to the research questions raised. In my study, I asked open-ended questions to elicit detailed descriptions that addressed the research questions. In general, the fewer participants in qualitative research, the deeper the inquiry level per individual participant.

In a qualitative study, the researcher needs to seek and obtain permission from individuals and sites at many levels. According to Creswell (2012), a gatekeeper is an individual who has an official or unofficial role at the site and gives the researcher entrance to the site and helps to locate the prospective participants. The gatekeepers in both study schools are the principals who were my first point of contact. Having obtained approval to conduct my research from the school district, I emailed both principals and enlightened them on the study's purpose and why I chose their schools for the study. Both principals directed me to the assistant principals who oversee the mathematics departments, and I explained my research proposal to them in person, face-to-face. I further explained possible benefits from the study for all stakeholders and that my research would involve me obtaining data from classroom observations, interviews, and documents, specifically, teachers' lesson plans. After receiving written IRB approval, I then sent emails to the qualified teachers and asked for their participation in my study.

It is vital in the research process to gain access to the intended participants. As earlier mentioned, after obtaining IRB approval, I sent an email to both assistant principals who were administrators over the mathematics departments. I informed the assistant principal (AP) in school A that I would email the intended participants about collecting data. I also emailed the AP in school B and ask for the names and email addresses of the qualified intending participants. Since I already knew the intending participants' email addresses in school A, there was no need to ask the AP in school A. I then sent a letter of invitation to each intending participant via email to introduce myself and inform them of my project study's purpose. The letter of invitation spelled out the confidentiality of all information obtained from each participant. To give their consent to be observed, interviewed, and collect lesson plans from them, they had to send the researcher an email with the words, "I consent." I interviewed all the participants and observed 9 out of the 11 participants. Each of the 9 participants observed submitted three lesson plans.

After receiving my initial email to the school B participants, I followed up on the invitation letter with a phone call. The phone call began the process of establishing a rapport with them. This part of the process was necessary because good rapport forms the basis for successful communication. In school A, this part of the process was not required because the FOA teachers were already known. It was vital in the research process to develop a rapport with the intended participants. Rapport is feeling comfortable with someone or a group of people by having things in common that will help make communication easier (Youell & Youell, 2011).

I then emailed each participant the letter of consent, which explained in detail what these teachers' participation entailed. The consent letter also included some of the open-ended interview questions and the role of the researcher. I emphasized to the participants that all the information that I would obtain from them would be kept entirely confidential throughout the process. The researcher must collect data, analyze data, and report it without compromising the participants' identities. Each participant was assigned an alpha-numeric code. All information collected was stored in my laptop's hard drive, a jump drive, and my vault in my OneDrive account, which is password protected. The external hard drive was stored away and would be kept for five years after the study was published. The copy of the interview and observation notes were kept in a safe place and would be destroyed after at least five years following Walden University policy.

After receiving all participants' responses, I emailed a response highlighting some critical reminders. Participation in this study is voluntary, and they could choose to opt-out of the study at any time. I would observe one class of their choice and interview each participant for 45-60 minutes at a time and location of their choice. Each participant would submit three lesson plans for three consecutive weeks as part of the data collection. The interview would be recorded with their permission on a digital recorder to facilitate collection of information, and later transcribed for analysis. It was also made clear to the participants that I did not represent the school district; therefore, there would not be any conflict of interest.

I ensured that I collected rich descriptive data from the participants. I then arranged appointments with each intended participant first for observation, and then for interviews based on their availability. After the interviews, I used member checking by allowing the teacher participants to read the interview transcripts and the conclusions reached from my interview sessions.

Data Collection

The conceptual frameworks of Bruner's constructivist theory and Vygotsky's ZPD guided my data collection. Data sources for qualitative studies are usually observations, field notes, interviews, interview documents, qualitative texts, audio and video recordings, relevant documents, and theory (Creswell, 2015). In this study, data collection was through semi-structured in-depth interviews, direct observations, and a review of lesson plans. Interviews are a vital source of evidence for case studies and are also a primary data source in qualitative research. According to Creswell (2015), a qualitative interview occurs when a researcher asks one or more participants general or open-ended questions and record their answers for further analysis.

One advantage of observations as a source of data for qualitative research is that it takes place in the setting where the case or phenomenon of interest naturally occurs. Observational data are typically a firsthand encounter with the case of interest and not a secondhand account of the phenomenon (Merriam, 2009). Despite critiques against observations as a research tool for reasons of the subjectivity of the observer and selectivity of human perception, observations as a credible source of qualitative data can capture things that may otherwise go unnoticed by the participants. According to Merriam (2009), observations are conducted in conjunction with observations and document analysis to triangulate the study's emerging findings. Observations usually include a description of the setting's activities and a reflection about themes and personal insights that were noted during the observation (Creswell, 2012).

Classroom Observations

Although interviews were my primary source of data for this study and observations are secondary to interviews, I conducted my observations first before conducting interviews to enable me to use the observational data to create probing questions for my interview protocol. I observed all participating FOA teachers that I interviewed. I tried to schedule the observations at times that were convenient both for the participants and the researcher. The observation protocol I developed using Creswell's observational protocol sample as a guide addressed the research question of FOA teachers' scaffolding strategies. The observation protocol (see Appendix B) was based on the constructs of the framework.

The protocol included the time and length of the observation, date, and the pseudonym assigned to each teacher participant. These observations provided indications of current practice or dependable samples of teaching practice within the school district. In either of these cases, the observations' purpose was to collect data regarding what occurred in the FOA classrooms. Another purpose of observations was to raise questions about existing scaffolding strategies utilized by FOA teachers and the conditions under which they utilized them. The observation protocol (see Appendix B) focused on teacher performances under the following sections: teacher-student interaction, socratic questioning, scaffolding strategies, and ZPD. A section of the observation protocol was used to record descriptions of what I observed in the classrooms. This section is otherwise known as observation notes, which should be highly descriptive. Creswell (2015) suggested that field notes should include a description of the participants, the setting, activities, or behaviors of participants, and what the observer does during the observation. The observation protocol notes provided answers to RQ2.

Semi-Structured Interviews

My interview protocol was guided by the scaffolding elements of Bruner's constructivist theory and Vygotsky's ZPD. The interview protocol consists of open-ended questions that were used to conduct one-on-one interviews with the participants (see Appendix C). However, probes were questions or comments that followed up the questions in the protocol. Interview protocol questions provided answers to RQ1. Lesson plans provided answers to RQ2. Before transiting into asking the interview questions, I asked a few icebreaker questions and explained my project study. The icebreaker questions were intended to put the respondents at ease with the researcher to obtain qualitative information for analysis. The interview took place in an agreed-upon location between each participant and me at a convenient time and day (i.e., before or after school). The interviews lasted between 25 and 45 minutes and were audiotaped via a Philips 4GB Voice Tracer Audi Recorder. The same interview protocol was used for each semi-structured interview. However, follow-up questions were asked as deemed relevant within each interview. At the end of each interview, I thanked the interviewee for taking the time to participate in this study.

Document Analysis

The third source of data for this study was from documents. According to Merriam (2009), data from documents can be used in the same manner as data from interviews and observations. One advantage of using documentary material is its stability. It is an unobtrusive source of data as the researcher's presence does not alter what is being studied. In case studies, the most critical use of documents is to corroborate and augment evidence from other data sources (Yin, 2014). The documents I reviewed for data analysis were the lesson plans of the FOA teachers. I asked each teacher participant to bring their lesson plans for three consecutive weeks. The second lesson plan was for the week that the participants were observed. Lesson plans were collected after each interview. Lesson plans usually delineate the instructional strategies to be used in each lesson. Therefore, information from this document was used to answer the second research question of how FOA teachers scaffold their students' learning. I used the researcher developed lesson plan protocol to analyze the teachers' lesson plans.

I recorded all the procedures for data collection. I used Otter.ai and NVivo software to transcribe the interviews, after which I reviewed the transcript and edited them for accuracy and stored them in the categorized, labeled folders that correspond with their assigned alpha-numeric codes for easy retrieval. For instance, the first teacher in school A was assigned the code TA1, the second teacher in school A had the code TA2, and so forth. The first teacher interviewed in the second school was assigned the code TB1, and the second teacher in school B was assigned the code TB2, and so forth. These codes were the names of each data file. Saldana (2013) recommended placing all the data in one single working file with the original and complete data sets in separate backup files. According to the assigned codes, all other data from observations and document reviews were also stored in computer folders. Each folder housed three files, namely, data from the interview, observation, and lesson plans. For instance, data for the first teacher in school A were stored in a folder named TA1 with files called TA1-Observation, TA1-Interview, and TA1-Document.

Role of the Researcher

This study was conducted in two high schools, high school A, where I worked as a ninth-grade mathematics teacher at the time of this study, and high school B, both in the same area and school district. At the time of this study, I was the FOA team leader, which was not a supervisory role. I, therefore, did not have supervisory responsibility for the participants in high school A. Since I did not have a supervisory role, I did not influence the teacher participants' responses in school A. As a teacher, I looked forward to practicing the scaffolding strategies I learned from my study in my classroom. Further, my proximity to school A participants made it easier for me to schedule observations and interviews. However, I made it clear to the teacher participants that I was not representing the school district, and my role in this study was that of a graduate student researcher. I also did not know the participants in high school B before this study. The process of qualitative research involves participants selection, designing the data collection instruments, collection of data, data analysis, interpreting, and synthesizing findings; I was fully involved in the process. This study was approved by Walden University's Institutional Review Board (IRB) and the school district of this study's setting. I conducted the study following all Walden IRB guidance (IRB approval number 12-11-19-0498083).

Data Analysis

Data analysis means making sense of collected data, and this involves consolidating, reducing, and interpreting all the information gathered from all the sources (Merriam, 2009). Data analysis is the process of using data to answer the research questions. I used thematic analysis to analyze my data. My approach to this study was based on some elements of Bruner's constructivist theory and Vygotsky's ZPD. Thematic analysis is a process used to analyze qualitative data, and it involves the searching across a data set to find repeated patterns of meanings (Percy, Kostere, & Kostere, 2015). There are three types of thematic analysis, namely, inductive analysis, thematic analysis, and thematic analysis with constant comparison. However, in this study, I used both inductive and deductive analysis. Inductive analysis is data-driven; the researcher does not fit the data into preexisting categories (Percy et al., 2015). Deductive coding was based on the tenets of Vygotsky's ZPD and Bruner's learning theory while allowing for themes to emerge from the data using inductive analysis.

The first step in this analysis process was to review and familiarize myself with all the data that I collected from interview transcripts, descriptive observation notes, and documents (lesson plans), after which I commenced coding by data set starting with the process of *a priori* coding. This type of coding entails assigning codes to all the data based on Bruner's learning theory and some elements of Vygotsky's ZPD. Next, I continued with open coding of the *a priori* codes, which involved highlighting words, phrases, or sentences that appear to be meaningfully related to my research questions. However, I noted the information not related to my conceptual framework's constructs and stored them in a separate file, as I referred to the file later. I analyzed all the data from observations, interviews, and lesson plans simultaneously as I collected the data instead of waiting to collect all the data before analyzing them. Then I took each data set and coded each data set with a serial number like A101, which was a simple way to keep track of each data set's individual items. The next step in the coding process is axial coding, which is a 2-step process. Axial coding involves categorizing each data set according to common terms and patterns and labeling them with a phrase or statement that describes the category (Percy et al., 2015). First, I formed categories of the open codes based on the relationship among the open codes and the raw data. Next, I searched for patterns among the categories to form temporary themes for each data set. The temporary themes were either phrases, or a statement based on patterns from the axial codes.

The next step in the analysis process is thematic analysis. I took all the patterns and looked for overarching themes that emerged after the completion of axial coding. This process involves putting all the related patterns together and assigning yet another word or phrase to describe the category. After analyzing all the data, I arranged the themes in a matrix with their corresponding supportive patterns. I then included the codes (descriptors) for each category. I completed this process for each participant's data and combined the data analysis for all the participants and included the patterns and themes that were consistent across the participants' data. Finally, I synthesized all the themes of the data to address my research questions.

Evidence of Quality

Credibility and trustworthiness issues were addressed through the analytic processes of data triangulation, i.e., using data from different participants or in different settings or only using multiple methods to collect data and participant checking, which allows participants to make comments on interview transcripts and emerging findings. Also, another experienced researcher helped me to code my data. To enhance this research study's credibility, first, I accounted for any personal biases that may influence my research outcome, recording them in a reflexive journal. I also acknowledged any biases in sampling and ongoing critical reflection of sampling methods to ensure enough depth and relevance of data collection and analysis. I maintained a clear and detailed record of my thought processes throughout the research to ensure consistent and transparent data interpretations, which is evident in an audit trail.

The triangulation process involved using the other methods and perspectives of data collection and observations and documents to produce a more comprehensive set of conclusions (Noble & Smith, 2015). Triangulation is corroborating the findings across data sets. In addition to using triangulation as a strategy for promoting validity and reliability, I used member checking to enhance my research findings' credibility. Due to the turnout of events in our world at the time of collecting and analyzing data, I sent an email of my study's findings to each of the participants for them to check the accuracy and completion of their contributions. This process allowed the participants to clarify their responses, correct, or add to their contributions to the study. A few of the participants responded with some clarifications and additions to their responses via email. I also maintained a high level of objectivity and professionalism throughout the study. I also kept the confidentiality of all participants by using alpha-numeric codes for each of them.

Data Collection Process

I collected qualitative data from a sample of high school teachers who currently teach FOA and Algebra 1 and those who have taught them within the last year. After receiving approval of my proposal from the Walden University IRB, I then emailed the administrators of the mathematics departments in the two high schools, which are my project study sites. The IRB approval number is 12-11-19-0498083. The purpose of my email was to inform them that I was ready to collect data from my participants. I then emailed all my proposed participants the consent form. After receiving the consent of my participants, I scheduled appointments to observe them first before interviewing them. In planning these appointments, careful thought was put in place to ensure that I complete data collection within two months as there were two school holidays to consider.

Table 1 shows the demographic data and years of experience of the 11 teachers who participated in this study: seven in school A and four in school B. Eight of the participants were female and three were males. Nine of them were general education teachers and two special-education teachers. I first conducted observations from January 29, 2020, to February 12, 2020, then held face to face interviews from February 19, 2020, to March 4, 2020. As events in our world turned out, our school district implemented the lockdown from March 16, 2020. However, Walden University approved alternative data collection formats to replace face-to-face contact with email, phone, video conference, or online form. I conducted three of the interviews via email and one was conducted via telephone.

Table 1: *Demographics of Participants*

Participant Identifier	**Gender**	**Ethnicity/Race**	**Years of Teaching Experience**	**Teacher Type**
TA1	Female	African American	1.5	General Education Teacher
TA2	Male	African American	7	Special Education Teacher
TA3	Female	African American	20	General Education Teacher
TA4	Female	African American	25	General Education Teacher
TA5	Female	African American	12	Special Education Teacher
TB6	Female	African American	2	General Education Teacher
TB7	Female	African American	10	General Education Teacher
TB8	Male	African American	14	General Education Teacher
TB9	Male	African American	3	General Education Teacher
TA10	Female	African American	49	General Education Teacher
TA11	Female	African American	6	General Education Teacher

Data Collection

I conducted nine teachers' observations: seven of them who taught Algebra 1 and FOA in the previous semester (six general education teachers and one special-education teacher). For the most part, these seven participants had the same students they taught a previous semester in FOA classes. At the time of this study, the other two teachers were one general education teacher and one Special Education (SPED) teacher teaching a repeat FOA class. The observations lasted between 40 and 90 minutes. I took notes during my observations and later typed out my observation notes. The observation notes were stored on my password-protected personal laptop computer, jump drive, and personal vault within my OneDrive account, password protected. A personal vault is a place within OneDrive with an extra layer of security. I conducted 11 interviews, six face-to-face, one via telephone, audio recorded, and four via email. I used Otter.ai and Nvivo software to transcribe the interviews; I reviewed the transcriptions and edited them for accuracy. Interview recordings and transcripts were also stored in the hard drive, a jump drive, and my vault in my OneDrive account, password protected. I also obtained lesson plans for three consecutive weeks from nine of the teachers. The last two teacher participants that I only interviewed taught FOA and Algebra 1 in the previous year of this study and were not teaching these courses at the time of this study.

Findings

This study sought to address the problem that little was understood by the district administration and educators about the FOA teachers' scaffolding practices in high schools A and B. Therefore, this qualitative case study aimed to investigate FOA teachers' scaffolding strategies and how they scaffold learning for FOA students through a constructivist lens. The conceptual frameworks that guided this study's purpose were grounded on Bruner's constructivist theory and Vygotsky's ZPD. Figure 2 shows the relevant constructs of both theories that guided this study. The conceptual frameworks influenced the data collection instruments, which are the observation and interview protocols.

The most crucial stage in analyzing qualitative data is the coding stage (Williams & Moser, 2019). The first set of data that I coded was observations. First, I created a framework matrix using NVivo software. Framework matrices are tables with cases (participants) in rows and *a priori* codes in columns that allow the researcher to summarize the data. The initial coding was based on the research questions and conceptual frameworks. There were 75 *a priori* codes created from the observation and interview data to answer the first research question of how FOA teachers describe their scaffolding strategies. There were 25 *a priori* codes also created from the observation and interview data to answer the second research question of how mathematics teachers scaffold learning for FOA ninth-grade students. Some of the codes were revised, while some were changed, and the next cycle of the coding process generated four categories (axial coding) I created based on the constructs of the conceptual framework and exported the framework matrices to an excel spreadsheet under the four groups. These four categories developed into two themes and five subthemes. The two main thematic groups are instructional strategies to provide mathematics content with five subthemes and a positive learning environment. The subthemes activate prior knowledge, socratic questioning, paces the lesson, uses manipulatives, visuals, teacher modeling, student grouping for learning and collaboration, and technology. I repeated the same process for the interview data and document data. I then wrote summaries of the interview data for each participant, then highlighted sentences and phrases based on the above themes.

Results of the Study

In this section, I examined the results which were organized by the research questions. The first research question (RQ1) was answered by the interview questions' responses, while RQ2 was answered by the observation notes and a review of the teacher participants' lesson plans. The interview data analysis included verbatim passages for illustration and some direct quotations from participants described in Creswell (2015). I displayed the most common responses instead of all the direct quotes. I present the results under two major themes: Instructional strategies to provide mathematics content and a positive learning environment.

Theme 1: Instructional Strategies to Provide Mathematics Content

Interview data. A close investigation of the teacher participants showed that they had a fair idea of scaffolding students' learning. The participants mentioned such scaffolding strategies as activating students' prior knowledge and building on it, questioning strategies, breaking down content into manageable parts to aid students' understanding, using manipulatives, visuals like anchor charts, teacher modeling, student grouping for learning, and the use of technology. RQ1 was answered through 18 interview questions in the interview protocol. Teachers were asked about how they support students' mathematics academic achievement through scaffolding instructional strategies. The following five subthemes emerged from their responses: activating prior knowledge, socratic questioning, pacing the lesson, manipulatives and visuals, and student grouping for learning, and technology.

Observations/lesson plan data. The observation protocol and lesson plans of teacher participants provided answers to RQ2. Only nine teachers were observed: the last two teacher participants, TA10 and TA11, were not teaching FOA or Algebra 1 at the time of this study but taught them in the previous school year. Five subthemes emerged after analyzing the observations and lesson plans. These themes represent observations of the different ways that teachers scaffolded the learning of their students. The subthemes are activating prior knowledge; socratic questioning; paces the lesson, uses manipulatives, visuals, and teacher modeling; student grouping for learning and collaboration, and technology.

Activating Prior Knowledge

Interview data to answer RQ1. All the teachers activated prior knowledge for problem-solving and connecting prior knowledge to new knowledge to be learned. In their mathematics classes, problem-solving led to solving more challenging problems. To teach a new concept, teachers made connections with students' prior knowledge and the new concepts taught. Teachers shared that they referred to this connection throughout their lessons. Brainstorming with students on what they already know, asking leading questions, using quick oral drills, and quick checks were frequently used to activate prior knowledge. Additionally, TA2, TA4, and TA5 reviewed vocabulary relevant to the topic; TA4 and TA9 used real-life applications and students' experiences and interests to activate prior knowledge as scaffolding teaching and learning. Activating prior knowledge was usually applied during the warm-up sessions or Do-Now sessions in the first 10 minutes of class.

For instance, TA4 mentioned that she uses the KWL chart to activate students' prior knowledge and engage them in a new lesson. TA4 said:

> Graphic organizer allows me to see what the students already know. For example, if I was doing a lesson on quadratic equations, students would write down everything that they know about quadratic equations, functions, graphs, and any prior experience that they acquired about this concept. Something to see, can I tap into what their prior knowledge?

TA4 used the KWL chart to activate students' prior knowledge about vocabulary or real-word application related to the concept taught.

TA5, a SPED Teacher, said:

> As a warm-up, we will do a quick check where each student has a different problem. During the quick check, I will give them vocabulary words to identify in the question. Each student will have to explain their steps by using vocabulary words. This is needed daily because some students do not retain information well and need a daily reminder. Sometimes, I will give them a blank piece of paper and ask them to write down what they learned yesterday.

TB9 said:

> Students learned how to solve equations in middle school. They play video games at home, which is a gaming system. I took their knowledge of the gaming system and asked them how the components of the gaming system worked together. I took their answers and tailored them to Systems of Equations and how the two equations worked together to find a solution, infinite solutions, or no solution.

TA11 emphasized and summarized the importance of activating prior knowledge as a scaffolding strategy. She said:

Students tend to be more successful when they can make connections to what they already know about a topic. Covering a new topic can be daunting and intimidating at times. However, they become more confident when they have a concrete understanding of a pre-requisite skill or concept that they can build on.

Observation/lesson plan data to answer RQ2. TB6 was the only teacher who was observed activating prior knowledge. During the second work session, TB6 activated students' prior knowledge by referring them to a previous problem that one of her students has solved at the board during the warm-up session.

TB6 said that she activates students' prior knowledge to scaffold their learning and data from observations, and her lesson plans confirm her claim. Although the remaining eight teachers who I observed said that they activate their students' prior knowledge to scaffold their students' learning, this aspect of scaffolding was not seen during the observations. However, in their lesson plans, all eight teachers indicated their plans to activate their students' prior knowledge through Math Talks, reviewing vocabulary using a vocabulary matching activity, and the website called Flocabulary. The Flocabulary site uses a non-traditional approach to teaching vocabulary, United States history, mathematics, science, and other subjects by integrating content into recorded raps. Some of the lesson plans also included activities such as Fishbowl, Two Truths and a Lie, and riddles, which can be used for Math talks. Math Talks is a 10 to 15-minute whole group mental mathematics activity where students find the answer to a mathematics problem in their heads. Then students share aloud the strategies they used to find that answer. This strategy helps develop quality student discourse in a whole class setting as students are encouraged to explain their thinking, justify their reasoning, and make sense of each other's strategies.

Socratic Questioning

Interview data to answer RQ1. All 11 teachers said that they use some sort of questioning strategy to scaffold their students' learning. They mentioned that they ask "leading," "low-level," and "probing" questions to provoke students to think through the problem. They also mentioned that they start with asking easy questions and then progress to more challenging questions with real-world scenarios. For instance, TA2, a SPED teacher, asks students low-level questions. TA2 uses voice inflections to give hints to answer the questions. TA5 encourages students to "read questions twice and ask themselves what the problem is asking, what operation is involved in the question, and why they think so."

In response to the question about questioning strategies for students struggling with a mathematics problem, TB6 explained:

> A situation where I asked specific questions when scaffolding the material is when students were learning to simplify radicals. I taught them the ladder method first. I asked: "what are prime numbers?" I also asked: "What is the difference between a perfect square and non-perfect square? Then I asked, "How do you think we can simplify a non-perfect square?" This allowed students to reflect to prime and composite numbers as well as a number to the 2^{nd} power.

TA10 said:

> I kind of look at what is the biggest problem, and I create problems on the spot. I will start questioning them if two or more students come up with the same type of questions. Just throw the question out to see if we can come up with an answer. I am not directing the question at any one student. I will say okay, you all, what is such and such and someone usually comes up with that and then we will go from there.

TA1 said that she learned about funneling questions during her master's program and tries to practice asking students leading questions. TA1, however, thinks that her students are not receptive to questioning because they seem to struggle more with reading comprehension than doing mathematics. TA1 strives to support students and is working on learning new strategies.

Observation/Lesson plan data to answer RQ2. All eleven teachers were observed using socratic questioning to scaffold their students' learning, which they revealed during their interviews. I observed all the teachers pausing after asking leading questions. For instance, during the lesson on estimating square roots in the small group class of SPED students, in trying to estimate the square root of the number 52, TA2 paused after asking his students, "What two integers will the square root of fifty-two fall in between?"

I observed other socratic questioning practices; TA3 helped her students extend their responses and demonstrated active listening. In TA3’s class, students worked on completing a set of factoring diamonds by figuring out what two numbers total an unknown number in the diamond one and a different answer when multiplied in diamond 2. When the students completed the task on the board, TA3 reviewed the solutions with the whole class. TA3 asked students, “Is number 5 correct? Why not?” A student replied, “I don’t know” TA3 responded that “I don’t know, is not an answer.” Then students explained the integer rules. TA3 then called each of the students who worked on the board to explain their solutions to the whole class. For instance, a student explained: “If you multiply six by -4, you get -24, and if you add 6 and -4, you get 2. TA3 also drew a non-participating student to answer a question on what two numbers total an unknown number in the diamond one.

While TB6 walked around the room and monitored each group of students, she asked them questions, such as “What does the word ‘per’ mean? A student asked, “How do you change from slope-intercept form to standard form?” TB6 answered the question by modeling to the student the solution to the problem, then problems were assigned on Deltamath to the student. TB6 directed the student to refer to the anchor charts in the room or talk to a table partner if help was needed.

A close look at the lesson plans data showed that all nine observed teachers indicated plans to ask questions that would prompt students’ thinking. However, only one of the teachers, TB7, listed the questions to be asked during her lesson. The other teachers’ lesson plans included plans to ask direct questions and hold question and answer sessions during their lessons.

Pacing the Lesson, Using manipulatives, and Visuals

Interview data to answer RQ1. All 11 teacher participants mentioned breaking down content during instruction, breaking down the vocabulary words of the standards, giving tips, and anchor charts. Also, students used manipulatives, cellphones, learning stations, and visual aids. Teachers employed peer teaching, guided practice notes, Cornell notes, thinking maps, and quick reference guides in students' folders.

Pacing the lesson. Pacing lessons is one way that teachers can scaffold their instruction and ensure that the content is grade appropriate. FOA, being a remedial course with students who struggle to overcome the fear of mathematics and have a growth mindset, demands much scaffolding. Therefore, it is imperative to pace the lessons so that they are not overwhelmed by information overload.

TA1 described her scaffolding strategy as "slowing down the pace of instruction for her students." TA1 mentioned that about half the students had Individualized Learning Plans (IEPs) and needed more support. TA1 said content is broken into manageable portions since her students often need help with reading and comprehension of mathematics problems. TA6 mentioned that her primary strategy for scaffolding her students' learning is to chunk the content for students to learn the standard a piece at a time, allowing them to focus on the part of the standard that they need the most help. TB6 said she also does mini-lessons and breakout groups, allowing students to learn at their own pace.

Visuals. Visual aids are imagery like pictures, graphic organizers, graphs, tables, small white boards that helps to actively engage the learner, making it easier for the learner to recall the content. Seven out of 11 Teachers mentioned that they provide some visual aids for their students to aid their learning such as anchor charts, graphic organizers, and small whiteboards. TA4 uses visuals to engage her students more deeply in their learning. TA4 mentioned that “students need to have many anchor charts explaining vocabulary and notes for them to follow along with me. They can also use a recorder to follow along.” TA5 said that she provides “visual aids usually in graphic organizers and step-by-step problem-solving checklist.” TA2 mentioned that he uses colors in his presentation to appeal to his visual learners.

Manipulatives. Only two (TA4 and TA7) out of the 11 teachers mentioned that they use manipulatives to scaffold their students’ learning. For students who need hands-on activities, TA4 said she has manipulatives. TB7 mentioned that she uses manipulatives during instruction, adding that manipulatives give a visual for visual learners.

Observation/lesson plan data to answer RQ2. Although all 11 teachers mentioned that they use some or all these scaffolding strategies, pacing the lesson, manipulatives, visuals, and teacher modeling to support their students’ learning, I did not observe all teachers using these strategies. I observed six teachers using at least one of these strategies to scaffold their students' learning. For instance, TA3 and TA4 paced their lessons by giving their students guided practice notes, breaking down factoring trinomials into steps. TB6 paced her lesson by chunking the activities into timed pieces. TB7 paced her lesson also by using a timer for the different sections of the lesson. TB7 pointed a student to an anchor chart to remind her of the process to convert the standard form of a linear equation to a slope-intercept form. On three occasions, TB7 projected word problems on the board via PowerPoint and asked two different students each time to read the word problem aloud. After the second reading, TB7 explained the 3-2-1 strategy to students – 3 minutes to read the question and figure out how to solve it. The next 2 minutes for students to talk to each other about the problem. One minute for TB7 to review the question with the whole class. TA5 gave them time to evaluate then reviewed the problems with the class. TB8 also set a time limit during the work session for a group activity.

In their lesson plans, the nine teacher participants who were observed, planned lessons using different strategies to pace their lessons and engage students during the work sessions. Guided practice notes, completing graphic organizers, anchor charts, "cheat sheets," differentiated activities for the different levels of learners – beginning, developing, proficient, and distinguished - were noted in the lesson plan data. Examples of the activities planned were Tic Tac Toe, gallery walks, Skoot, Jig Saw, Pick and Fan, and Scavenger Hunt. For the Tic Tac Toe activity, students were to factor the quadratic expressions using Greatest Common Factor correctly to claim the square. For the Skoot activity, students would calculate factoring tasks from quadratic expressions and scoot from desk to desk solving quadratic equations during a specified time interval. For the Jig Saw activity, students would work in groups of four. Students were to focus on their specific quadratic type then teach it to another group. For the Pick and Fan activity, students would work in groups, pick, solve, and check quadratic problems. The Scavenger Hunt was designed for practicing factoring using common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor completely. The answer to each problem led students to another problem in this activity.

TA1 used Cheez-It as manipulatives to model estimating square roots of non-perfect squares. The use of Cheez-It as manipulatives was planned for this lesson as corroborated in TA1's lesson plans. Although I did not observe TA2 using manipulatives, he included creating a clothesline as a manipulative on the board and using it to teach ordering benchmark fractions. I also did not observe TA4 using manipulatives, TA4 indicated in her lesson plans the use of versatiles as manipulatives for unit review stations activity.

I observed four teachers using visuals such as small white boards and anchor chart. TB7's students practiced solving system of equations on whiteboards. TA1's students also practiced estimating square roots on individual small whiteboards. I noticed anchor charts in all the classrooms observed. I observed TB7 referring a student to one of the anchor charts that had an example of solving a system of equations. TB6 and TB9 also directed some of their students who asked for help during the work session to specific anchor charts in the room. In their lesson plans, however, TA1, TA2, TA3, TA4, TA5, TB6, TB8, and TB9 included visuals like the use of small whiteboards, graphic organizers, and anchor charts.

I observed teacher modeling in the classes of TA1, TA2, TA3, and TA4. Using the I do-We Do-You do model of instruction, these teachers demonstrated how to solve some problems in the I do section of the guided practice notes and provided an oral narrative to explain the process. TA1 modeled how to estimate square roots using Cheezits as manipulatives, and TA2 modeled the process of estimating square roots using the number line. TA3 and TA4 modeled factoring a trinomial as they gave guided practice notes, and asked questions as they provided verbal explanations of the process of factoring some examples of Quadratic Trinomials. At the same time, the teachers also asked students questions in between the guided practice notes. Students were engaged in taking notes and responding to questions (TA3 and TA4). Although TB9 said that part of his scaffolding strategies is modeling, I did not observe modeling in his classroom. TB9's lesson plans, however, showed plans to model solving problems and providing oral explanations of the process in the guided practice notes. Only TA5 did not plan for modeling.

Student Grouping for Learning

Interview data to answer RQ1. The purpose of grouping students is for them to learn from each other and improve their thinking skills. It is expected that students in groups collaborate by brainstorming and talking through the questions or problems that have been assigned to the group. Nine of the 11 teachers said that they use student grouping for learning to scaffold student learning. They pair high-performing students with low-performing students, and group students with mixed abilities together. For instance, TA1, TA3, TA4, and TA10 mentioned that they practice paired grouping of students to learn from each other. Three out of these four teachers said they match their lower-performing students with high performing students, while TA10 said she paired students homogeneously, the high-performing students collaborated in pairs, and seated the low-performing students closer to her so that she could coach them. TB7 said she sometimes uses a peer teaching strategy, which she modified from the "My favorite No" strategy. TB7 presents two problems on the board and asks the class to pick up an index card if they know how to solve them. The students who solve the problems correctly in three minutes will be the teachers during the work session and are given the opportunity to teach the rest of class three given problems.

Teachers TB6, TB8, and TB9 mentioned that they create mixed ability learning groups. TB6 for instanced explained that grouping students with mixed abilities or performance levels allows them to brainstorm and learn from their peers. TB6 said all her students have different strengths, and this allows them to reinforce what they know, and gain knew knowledge from other students. TB8 mentioned that he uses Kagan's active learning strategies to group students for learning. He identified four different achievement levels in his students based on the descriptors of the state's test achievement levels – beginner (L1), developing (L2), proficient (L3), and distinguished (L4). His example of the "Numbered Heads Together" cooperative learning strategy ensures all students actively collaborate. This strategy holds each student accountable for learning the assigned material as they work together in groups. The TB8 added that he groups students in different ways to keep them engaged and not bored and always encourages peer tutoring. TB8 explained that student collaboration promotes peer tutoring so that struggling students learn from high performing students. TB8 said that he often makes the highest performing students (L4) lead the groups and give valuable feedback to him. TB8 further explained that when the students form groups, they first collaborate within their levels, i.e., level 1s brainstorm with each other, level 2s do the same thing, and so on. Then, the students provide scaffolding to group members when they report back to the group. For example, level 4 students provide scaffolding for the level ones, twos, and threes.

TA10 paired students to collaborate rather than placing them in groups of more than two. She said:

> They may collaborate with the table partner… I don't use that. I stick to two, because when the groups get bigger, you find the students will rely on the person who knows the material, and that student is going to be the one that does most of the work and the other ones will sit back.

Both SPED teachers do not use student grouping for different reasons. TA2 said that when he has the SPED students in a separate room, he does little or no student collaboration because of the students' low level of maturity. TA2 explained that "Group work or collaboration is tough in 9th grade; they tend to get off track a bit," while TA5 emphasized the need to provide a different strategy for slow learners.

Observation/Lesson plan data to answer RQ2. Cooperative learning was observed in eight out of the nine classrooms. Most instances of grouping for learning involved pairs of students; however, I did observe students working in groups of three or more. For instance, in TB6's classroom, TB6 gave students time to brainstorm on a system of equations problem. Six students indicated they were level 4 worked together in a group for learning, while some worked independently. Students were in groups of learning in 3s and 4s. TB6 asked guiding questions to help the students (below L4) see and understand that slope is the rate of change or the value that changes. Some students were engaged as they worked on their laptops. Other students read out loud the word problems. TB6 pulled up a problem on delta math for students who were still struggling with the word problem.

TB8 used the concept of a relay race to group his students to solve sets of questions on systems of equations. Each group had an envelope of 4 different questions, and when each group completed all questions, the group leader (4th legger) checked the work of the other group members and collected another envelope of questions. The third leggers worked on elimination problems, the second leggers worked on substitution problems, and the first leggers worked on graphing systems of equations. TB8 reiterated to the students, that he needed to see independent work and allowed them to use their laptops to access desmos.com graphing calculators. The group with the highest number of envelopes with solved problems won the relay race. During the interview, TA2 stated that little or no grouping was conducted due to the immaturity of the students; however, I observed students who grouped themselves for learning in pairs or groups of three. I also observed that two students worked individually and independently.

The lesson plans of all nine teachers made provision for grouping for student learning in pairs, 3s, and 4s. In TA3's lesson plans, it was planned for students to pair with an "expert" student to review or work in a small group of two or three students with the teacher or co-teacher. Another plan was for students to choose their classmates (they know the students that performed better than themselves) to pair with, discuss questions, and be tutored by their peers. In the lesson plan of TB7, she included Jig Saw activity for cooperative learning. Students would learn in groups of four and focus their learning on specific quadratic type assigned to the group then teach it to another group.

Technology

Interview data to answer RQ1. Five of the 11 teacher participants mentioned their use of computer programs and assessment tools for leveled learning and assessment. They mentioned programs such as Ascend Math, Delta Math, Khan Academy, and Quizizz. For instance, when TA4 mentioned guided notes as a scaffolding strategy, she said, “They can do it on a recorder if they need a recorder or something like that, to follow along.” TA2 mentioned that he used the computer program, Ascend Math, to diagnose his students’ deficiencies first, then used the Ascend Math to remediate or teach previous standards to his student. TB6, TB7, and TB8 all mentioned that they use Deltamath. TB6 said that students complete tiered assignments on the computer and that the students advance to the next level after completing the first level.

TB7 mentioned that she uses Quizizz as formative assessments. Quizizz is a program that contains games and formative quizzes online. Students enter their quiz answers online and answers are recorded for teacher review. If she notices more red buttons than green ones on the quiz reports, that is an indication for her to pause and reteach the concept at hand.

TB7 explained further:

> Deltamath explains the mathematics concepts in detail. “Khan Academy increases rigor based on where students are so that a student might finish the

whole course. Before the end of the school year, I can go ahead and start working on geometry, possibly algebra two, based on their advanced ability."

TB7 provided data that I viewed as discrepant when compared to the other 8 participants' data. The discrepancy was in respect of technology-based scaffolding. TB7 mentioned the Photo-math app as one of the technology tools that she uses to scaffold her students' learning. TB7 encourages her students to use their photo-math app positively and not to cheat.

TB7 explained:

> Let's talk about how to use it the right way. Thus, students are now able to like to know, okay, I tried this problem. Let me check, let me photo-math to check it. Oh, I might have missed a step. Let me see what step I missed. Now let me ask my teacher. Thus, that's helping them to become more independent, I think, because, why not use technology? It is there, but let's use it positively.

Observation/lesson plan data to answer RQ2. I observed all nine teacher participants using multiple forms of technology. The technology used computer programs for leveled learning and assessment, videos, PowerPoint, and multiple sources on Smartboards. TB6, TB7, and TB8 said that they used computer programs like Delta math, Khan Academy, and Quizizz for practice and formative assessments. I observed students watching a video on solving Quadratic equations by factoring in TA5's classroom. TA5 helped her students to transition from real examples to an algebra type problem. I also observed and students working on problems on Deltamath.com in TB6's, TB7's, and TB9's classes. I observed teachers A1, TA3, TA4, TB6, TB7, and TB9 use

PowerPoint and smartboard technologies for teacher presentations to project questions to activate prior knowledge, open dialogue, and guided practice notes.

All the nine teachers observed, had plans that showed their students were to practice mathematics problems on Delta math, I Practice Math, Khan Academy, and Quizizz. TB8 included the use of Desmos.com, an online graphing calculator tool in his lesson plans, while TB9 included videos on solving systems of equations by elimination and factoring polynomials as part of the technology. TB6 also included videos on solving quadratic equations, PowerPoint notes slide, the use of Skype, and Remind text messaging to give her students feedback on solving quadratic equations in her lesson plans. Lesson plans of TA7 also revealed plans to use technology games for students to engage practice and reviews, like Mario Brothers for solving Quadratic equations and Jeopardy for review of solving systems of equations. TA1, TA3, TA5, TB9, TB10, and TB11 did not refer technology to scaffold their students' learning during the interview sessions.

Theme 2: Positive Learning Environment

A positive learning environment hinges on teacher and student, the behavior of the students, and how the teacher can manage those behaviors. Therefore, a positive learning environment is where there is a good rapport between the students and the teacher, among the students, and where students feel safe to make mistakes and learn from each other. Students develop trust and confidence in their teacher; therefore, students are free to participate in an open dialogue to facilitate their learning. Some components or elements positive learning and that will help to create and maintain a positive learning environment are strong classroom management, student teams, the teacher facilitates student engagement, positive reinforcement, open dialogue, and prompt teacher feedback (De Nobile, Lyons, & Arthur-Kelly, 2017; Hierck, 2017; Shernoff, Ruzek, & Sinha, 2017).

Interview data to answer RQ1. All the teachers mentioned that they give their students some formative assessments and give them immediate feedback. Nine out of the 11 teacher participants said that they invite student participation through open dialogue. The teachers mentioned that they engage their students in open dialogue. TA3 said she starts her day by having a problem at the board and asks students questions like, "So, what do we do?" She practices using wait time to provide students time to think about their answers and respond. She tells the students that she will write whatever they ask her to write. If a student provides a wrong answer, other students will correct it, so a class discussion or open dialogue ensues. TA9 said that he uses open dialogue to "determine their mastery level and to clear up any misunderstandings or misconceptions of the standard." TA10 noted that all her students "contribute to whatever we're talking about." She added:

> I'll build off what someone says, even if it's not quite the answer I'm looking for. I will give that student credit for that, and we will just build on to get myself back around to what I'm looking for.

TA11 said she often used open dialogue for error analysis and brainstorming problem-solving. She said: “There is value in allowing students to think on their own and then openly share their thought-process with their peers.” TB9 mentioned that he used

See, Do, Run as a team building activity in his classroom. This activity involves the teacher assigning specific roles to each group member, so holding them accountable to each other and the teacher. TB9 said that communication and collaboration were essential to the activity.

Observation/Lesson plan data to answer RQ2. I observed teacher-student interactions in all nine teacher participants. TA1 and TA2 offered motivational context to pique their students' interests or curiosity in estimating square roots. TA2, TA3, TA4, TA6, TA9 all attended to some of their students who had questions about the problem. I observed positive teacher-student interactions in the above instances, which helps make students comfortable responding to teacher questioning, thus supporting a positive learning environment. TA3, TA5, and TB8 gave positive reinforcements to their students, which help to maintain motivation, interest in students, and student engagement. For instance, a student told TA3 that she was finished and asked if she could go up to the board to write her solution; TA3 said yes to her request. She answered correctly, and TA3 responded with, "That is fabulous! See if you can help someone else." TA8 praised his students for using the correct mathematics vocabulary.

TA5 gave high-fives to her students when they correctly solved some given problems and gave them positive feedback. TA8 gave students feedback as they worked in their groups. TA8 walked around, monitoring students, and reminded them to "ask three before me." To help promote a positive learning environment, TB8 rehearsed a celebratory chant for when the students get their assigned problems right, and TA3 incorporated some of her students' idea to play light jazz music while they worked. TA3 and TA8 played music in their classrooms. Music helps boost motivation and engagement (Aralas, Bokiev, Bokiev, Ismail, & Othman, 2018) which was evident as students were actively engaged in their practice. The lesson plans of all nine teachers showed their positive teacher-student interaction, which supports a positive learning environment. For instance, they included plans to call on students to answer questions, weekly teacher-student conferences, teachers working with a small group of beginning and developing students, and frequent intentional teacher questioning leading to critical thinking. TA1, TA3, TA6, and TA7 planned mathematics class discussions.

Summary of Outcomes

The following results answered both research questions: The interview responses answered the RQ1: How do FOA teachers describe their scaffolding strategies? All 11 teacher participants (100%) mentioned that they activate the students' prior knowledge, use some questioning strategy to scaffold their students' learning, and pace their lessons. However, only two out of 11 teacher participants (18%) mentioned using manipulatives as scaffolding strategies. Seven out of 11 teacher participants (55%) mentioned that they provide some visuals to their students as part of their scaffolding strategies. Nine out of 11 teacher participants (82%) mentioned using student grouping for learning and collaboration to scaffold their students' learning. Only one of the teacher participants (9%) mentioned modeling as a scaffolding strategy, and five out of 11 Teacher participants (45%) mentioned that they use technology as scaffolding strategies to support their students' learning. All 11 teacher participants (100%) mentioned some of the components of a positive learning environment.

The observation notes and lesson plans answered the RQ2: How do mathematics teachers scaffold learning for FOA ninth grade students? One of the nine Teacher participants (11%) activated their students' prior knowledge. However, all nine of the Teacher participants (100%) indicated in their lesson plans to activate their students' prior knowledge. All nine Teacher participants (100%) were observed using socratic questioning to scaffold their students' learning. Also, all nine participants (100%) included socratic questioning in their lesson plans. All the teachers (100%) paced their lessons in different ways. Also, all teachers (100%) indicated their lesson plans the different ways they planned to pace their lessons. However, one of the nine Teachers (11%) used manipulatives, and three of the nine teachers (33%) observed, indicated in their lesson plans, their intentions to use manipulatives. Four out of nine (44%) Teacher participants provided some visuals to scaffold their students' learning.

In contrast, eight of the nine teachers observed showed in their lesson plans the provisions they made to provide visuals for students. Four out of nine Teacher participants (44%) used modeling to scaffold their students' learning, while eight out of nine teachers planned modeling in their lesson plans. Eight of nine Teachers (89%) used grouping for students' learning to scaffold their students' learning. The lesson plans of all nine teachers (100%) made provision for their students' learning through varied interaction levels – working in pairs or more. All nine teachers (100%) used some form of technology (videos, computer mathematics programs, PowerPoint, and SmartBoard teacher presentations) to scaffold their student's learning. All the teacher participants (100%) included using technology as a scaffolding strategy in their lesson plans. All nine participants (100%) were observed to have positive learning environment components in their classrooms. The lesson plans of all the teachers corroborated this observation. The lesson plans included plans to lead whole-class discussions, have student-teacher interactions, have daily formative assessments, and inviting student participation. I discuss the interpretation of the outcomes of the main themes and subthemes in detail.

Interpretation of Research Outcomes

I explored scaffolding strategies as described and used by FOA teachers for their ninth-grade students' learning. The frameworks that guided this study, Bruner's constructivist theory and Vygotsky's ZPD, support this study's findings. The outcomes resulted from analyzing the data from interviews and observations of FOA teachers and their lesson plans. The outcomes of this study informed the PD that is presented in the next section.

Theme 1: Instructional Strategies to Provide Mathematics Content

This is the first major theme emerging from the interviews, the first set of data collected. The interview questions were crafted based on the conceptual frameworks of Bruner’s constructivist theory of learning and Vygotsky’s ZPD.

Subtheme 1: Activating prior knowledge. The first subtheme of this study was activating students' prior knowledge as a scaffolding strategy. All 11 teacher participants (100%) mentioned that they activate the students' prior knowledge. However, only 1 of the 9 Teacher participants (11%) activated their students' prior knowledge during my observation. Eight out of nine of the Teacher participants (89%) indicated in their lesson plans activation of students' prior knowledge. The interview and lesson plan data are consistent with the literature reviewed for this study. David (2017) found that students take ownership of their education by constructing new learning based on current and prior knowledge. Strategies for activating prior knowledge include brainstorming, using the KWL chart, reading aloud, thinking-pair-share, and reflecting on practice. The low percentage of teachers observed to activate students' prior knowledge represents a gap in scaffolding practices. Kong and Orosco (2016) emphasized the importance of building prior knowledge is not specific to one group of students. All students require building prior knowledge and benefit from its use. The practice of activating students' prior knowledge is not specific to a grade level, student group, or content area (King, McClendon, & Neugebauer 2017).

Subtheme 2: Socratic questioning. All the teachers were observed using socratic questioning to scaffold student learning. This observation was consistent with the conceptual frameworks of Bruner's constructivist theory and Vygotsky's ZPD, and the literature reviewed for this study. Socratic questioning is a scaffolding facilitation tool that involves asking low-level questions, recall-type or closed questions and high-level or open-ended questions that support critical thinking. Teachers can be more purposeful in asking low-level questions that support scaffolding for high-level thinking (Rozas, 2018). Teachers should also give students time to respond to the questions and provide them opportunities and time to practice.

Subtheme 3a: Pacing the lesson. Pacing lessons was a subtheme that emerged from the interview data. All 11 Teachers mentioned some methods that they use to pace their lessons. Teachers should segment (chunk or micro-uniting) instruction and activities into manageable increments or steps to effectively pace a lesson.

Subtheme 3b: Using manipulatives. According to the State's Department of Education, Overview of the FOA course, it was suggested that teachers should use appropriate manipulatives and technology to enhance student learning. However, the results of this study showed that only 2 (TA4 & TA7) of the 11 teacher participants mentioned using manipulatives as part of their scaffolding strategies. Also, one teacher – TA1, was observed using Cheez-it as manipulatives for an exploratory lesson on estimating square roots included in her lesson plan. Only three teacher participants included manipulatives in their lesson plans; the other teachers were TA2 and TA4. Manipulatives are concrete, so they provide kinesthetic learning and help students connect mathematics concepts and multiple representations (Desai & Safi, 2017). Manipulatives are also useful for remediation or one-on-one instruction (Miller & Satsangi, 2017).

Subtheme 3c: Visuals. Seven out of the 11 Teacher participants (55%) mentioned that they use visuals such as anchor charts, graphic organizers, posters, and small whiteboards to scaffold students' learning during the interviews. Four out of nine teacher participants (44%) provided visuals such as anchor charts, graphic organizers, and small whiteboards to their students during my observations. Eight out of the nine observed teachers included visuals for their students' learning in their lesson plans. The purpose of visuals is to shape students' thinking and retain knowledge, so visuals are an essential scaffolding strategy. Teachers can teach their students to use visuals to explore relationships among concepts and connect to prior knowledge (Chikiwa & Ssennyomo, 2020). Even though not all the teacher participants mentioned using visuals to scaffold their students' learning, the teacher participants may not fully know how important and helpful visuals are to them, especially remedial students. Teachers must be intentional about everything they provide to their students and make them functional. Visuals help students see the overview of the concept they are learning, make it easier to understand, remember, and apply it (Boaler, Chen, Cordero, & Williams, 2016).

Subtheme 3d: Teacher modeling. Only one of the teacher participants (9%) mentioned modeling as a scaffolding strategy during the interviews. Four out of nine teacher participants were observed using a think-aloud strategy to verbalize their thought processes during problem-solving. Eight of the nine observed teachers included modeling as part of their instructional strategies in their lesson plans. The observation data findings represent a gap in practice that can be addressed via PD to improve classroom practice for teaching and learning. When a teacher models problem-solving to students, it reduces the frustrations that some students experience when not understanding the concept.

Subtheme 4: Student grouping for learning. Out of 11 participants, 9 (82%) described part of their scaffolding strategies using student collaboration. However, all nine teacher participants use student grouping for cooperative learning to scaffold their students' learning in practice. This misrepresentation reveals a gap in knowledge on the part of the FOA teachers. Eight out of the nine teachers (89%) used student grouping to scaffold students' learning, and all the teacher participants included grouping students in their lesson plans. The findings were aligned with existing literature that supports scaffolding students' learning through grouping for cooperative learning. Research shows that grouping for learning increases students' foundational knowledge. In cooperative learning, each group member is responsible for learning and helping others in the group. The teacher closely monitors the group learning while providing some scaffold of the learning activity procedures, which increases students' confidence in group discussions. As presented in the literature review, some scaffolding strategies include students conducting, analyzing, and drawing conclusions in a group setting.

Subtheme 5: Technology. Five out of the 11 participants (45%) described part of their scaffolding strategies as using computer programs and assessment tools for leveled learning and assessment like Ascend Math, Delta Math, Khan Academy, and Quizizz. However, all nine teachers who were observed used technology in their instruction during the observations, and all nine teachers included some form of technology in their lesson plans. Although all observed participants used some form of technology, only five out of the 11 participants mentioned technology as part of their scaffolding strategies. Technology strategies that teachers can use to scaffold their students' learning include videos, multimedia, games, digital field trips, hand-held, and online graphing calculators (Bryant, Kang, Kolb, Kim, 2020; Bryant, Kang, Kim, & Ok, 2016). Also, teachers can use technology for student feedback (only TB6 included this in her lesson plans), and online workstations with software like interactive dynamic algebra software. Technology should be the last scaffold piece and should add value to learning goals, such as formative assessment tools used during the learning process like Quizizz, Engrade, and Socrative.

A plethora of computer technologies can be used in the classroom to elicit higher-order thinking skills and extend learning beyond the classroom. Examples of computer technologies include online personalized learning where teachers can create different activities based on students' interests and learning styles and give students feedback in real-time and gaming like Minecraft (Nu-Man & Porter, 2017). All educators must rethink what a successful mathematics class would like in the 2020s.

Theme 2: Positive learning environment.

All teacher participants (100%) mentioned factors that contribute to a positive learning environment in their classrooms, which is necessary for scaffolding students' learning. A positive learning environment is a place where there is a good rapport between the students and the teacher, and among the students, students feel safe to make mistakes, have an open dialogue, and learn from each other (Hierck, 2017). A classroom where the teacher uses evidence-based strategies such as the scaffolding strategies investigated in this study to aid students' learning has a positive learning environment (Hierck, 2017). It is critical to note that learning must be taking place in such an environment; therefore, activating prior knowledge, socratic questioning, pacing the lesson, manipulatives, visuals, teacher modeling, grouping students for learning, and technology are features that make a classroom conducive for learning. This outcome is consistent with the literature reviewed for this study by Mercer, Van de Pol, and Volman (2019) and will inform a PD based on this study's overall findings. A positive learning environment factors are functional student-teacher interactions and student collaboration for cooperative learning (Van de Pol et al., 2015).

The Project

The PD was created based on the findings' outcomes to address the gaps in scaffolding practices of FOA teachers. In consideration of the frameworks, findings, and recommendations from relevant literature, I developed a project named Scaffolding Strategies in Mathematics to address the gaps in practices and improve current teaching skills and introduce new strategies of the FOA teachers. Scaffolding Strategies in Mathematics PD include manipulatives, visuals, teacher modeling, activating prior knowledge, and technology.

Conclusion

In this section, I provided a detailed review of the research methodology for this qualitative study. The 11 interviews, nine observations, and 27 documents (lesson plans) provided rich and descriptive data from the 11 teacher participants. I presented an analysis of the responses to the interview questions, observation notes, and document analysis. This qualitative study investigated FOA teachers' scaffolding strategies and how they scaffold learning for FOA students through a constructivist lens. The initial NVivo qualitative data analysis software and manual coding were both used for the coding process, which was influenced by the following research questions:

RQ1: How do FOA teachers describe their scaffolding strategies?

RQ2: How do mathematics teachers scaffold learning for FOA ninth grade?

Two themes and five subthemes emerged after analyzing the interviews, observations, and lesson plans. The first major theme is instructional strategies to provide mathematics content with five subthemes. The five subthemes are activating prior knowledge, socratic questioning, pacing the lesson, using manipulatives visuals, and teacher modeling, student grouping for learning, and technology. The second central theme is a positive learning environment. These themes and subthemes represent how teacher participants described their scaffolding strategies and scaffold their students' learning. Based on the findings, I designed a project to address the gaps in knowledge and practice revealed by the study's findings. The project is a PD activity targeted at FOA teachers but also helpful for other mathematics teachers. Section 3 includes a description of the project and its components.

Section 3: The Project

Upon completing the research on FOA teachers' scaffolding strategies, I developed a project that I named Scaffolding Strategies in Mathematics (see Appendix A). The project is designed to address the problem of this study which is that educators understood little about the scaffolding practices of ninth-grade teachers of Foundations of Algebra (FOA), a remedial course. This section includes the project description, rationale genre, literature review related to scaffolding strategies, and plans for implementing the project. Research outcomes and professional literature concerning the FOA course and scaffolding strategies are the basis for the project.

Description and Goals

The PD project on scaffolding strategies for mathematics is a 3-day training program primarily targeted towards FOA/Algebra 1 teachers (see Appendix A). The purpose of the targeted PD training is to address gaps in practice revealed in the findings of this study to improve the teaching practice of FOA teachers in the school district and improve the achievement of FOA students in the district. There were gaps or inconsistencies in terms of knowledge and practice of manipulatives, visuals, activating prior knowledge, teacher modeling, and technology to scaffold the learning of ninth grade FOA students. The study results revealed that not all teacher participants described their scaffolding strategies as using manipulatives, visuals, activating prior knowledge, teacher modeling, and technology and practiced them as confirmed by the observation and lesson plans data. Therefore, the goals of this project are that first, teachers will be able to provide a comprehensive description of their scaffolding strategies. This goal will be evidenced through self-reflection in the formative assessment at the end of the workshop. Second, teachers will incorporate scaffolding strategies in their classroom instruction, and the project evaluation will evidence this at the end of the workshop.

The PD session lasts for three days and is designed for face-to-face and online delivery, depending on the situation and time of the training's actual delivery. There are three sessions on the first day of the training regarding manipulatives and visuals and two sessions regarding activating prior knowledge. A class on teacher modeling is taught on the second day. The third day includes one session regarding the use of technology to scaffold students' learning. The following subsections explain the rationale for choosing a workshop type of PD to develop the training.

Rationale

A PD session is the most suitable genre for this project. Students need to be prepared with the necessary skills to meet the challenges of the 21st century at work and in further education. One of the challenges is to bridge the skills and knowledge gap in the students. This implies that teachers must be well trained to meet those needs; hence, they need continued targeted and effective PD for teachers. Darling-Hammond et al. (2017) said that for PD to have the desired impact, it must be structured and scaffolded and result in positive changes in teaching practices and improvements in terms of student learning outcomes and achievements.

Remedial courses, such as FOA, need the best teachers to teach remedial students. Khouyibaba (2015) said that remedial students often do not have a growth mindset required for success in any subject. Teachers of such remedial courses must be highly motivated and passionate about teaching and be always prepared to teach and scaffold students' learning. Students whose teachers participated in PD scored higher mathematics grades than students whose teachers did not participate in PD. Some studies corroborate this trend. For instance, Kleickmann, Tröbst, Jonen, Vehmeyer, and Möller (2016) found that students taught by elementary science teachers who received high scaffolding training showed significantly higher achievement than did students taught by low scaffolding teachers. The high scaffolding group of teachers engaged in active learning activities that mimicked the processes by which they were to guide their elementary grade students.

In contrast, teachers' low scaffolding groups received very little support and did not focus on scaffolding practices. In another study, a survey of middle school mathematics teachers in Missouri, Akiba, and Liang (2016) found that student achievement growth rates were positively associated with average teacher collaboration, professional conferences, and informal communication colleagues. However, it is essential to note that these two studies spanned over five months to three years. In yet another study, Meissel, Parr, & Timperley (2016) found that students from the group of teachers who were trained made considerable gains in student achievement and further suggested that additional targeting of the PD would be required to improve equity across student groupings.

The PD session will focus on five scaffolding strategies: manipulatives, visuals, activating prior knowledge, teacher modeling, and technology. Careful consideration was given to the data analysis and outcomes of the research in Section 2 and relevant scholarly literature before developing the PD training project. The study results regarding activating prior knowledge, manipulative, visuals, teacher modeling, and technology were inconsistent and would need to be taught more during this PD session as these strategies are crucial to the FOA course. The following section focuses on PD and learning, to address the problem and criteria used to guide the training development.

Review of the Literature

The literature reviewed in this section involved PD as a potential solution to address this study's problem: the district educators knew little about the scaffolding strategies of FOA teachers. The project was developed based on the gaps in practice in activating prior knowledge, manipulative, visuals, teacher modeling, and technology, as revealed from the findings. Three adult learning theories guided the development of this project: andragogy, transformative, and experiential learning theories. Some of the andragogy learning theory's tenets are; first, adults need to know why they should learn something. For this project, teachers will know the purpose of the PD.

Second, adults want to know how learning will help them individually. Teachers will know the goals of the PD. Third, adults have a wealth of experience, so their prior knowledge and experience form a foundation for learning. During the PD sessions, teachers will have the opportunity to discuss colleagues' prior knowledge of scaffolding strategies, which will form the foundation for their learning. Fourth, adults need to be intrinsically motivated to participate in PD sessions, and PD involvement relevant to current teaching practices will aid their learning. Learning is a process of changing perspectives resulting from engaging in explorations, discussions, and experiments. The experiential learning theory involves focusing on learning based on experiences, so it occurs during hands-on and role-playing activities. PD sessions have discussions as well as hands-on role-playing activities embedded in the training.

There are different types of PD; they vary from learning in PLCs with personalized learning goals, workshops, seminars, mentoring, curriculum development, and coaching to study groups. However, what is critical for teachers is that the PD must be productive. Darling-Hammond et al. (2017) highlighted some essential elements of effective PD. These elements are essential for meeting the diverse needs of students and they include focusing on content. Professional learning that is content specific like PD session for mathematics teachers can be effective as the participants come with experiences that are a rich resource for further learning of the content. Effective PDs create opportunities for active learning. Activities and learning environments are created for the teacher participants to immerse themselves in experiences that are the same as the activities used in their classrooms. Effective PDs also include work-embedded collaboration. The initial collaboration among teacher participants continues after the PD sessions and such collaborations promote a positive school climate and culture to improve instruction which translates to increased student achievement and a strong support for each other’s pedagogy. Effective PD also includes model best practices coaching and support. Another element of effective PD is incorporating feedback and reflective practice. Lastly effective PD is usually offered over a period and not just a one-time experience.

Some of the PD types the teachers in these studies participated in were collaborative PD, professional conferences, seminars, and workshops. Teachers were engaged in the analysis of student work, collaborative assignments, self and group reflections of video recordings of teacher instruction, and unit planning for teachers' classrooms. A seminar is a form of PD where one or more experts make a formal presentation to attendees on a subject matter, and they are encouraged to discuss the topic of the seminar. A seminar is not appropriate for the project as it does not allow the participants to be engaged in any practical activity. A conference is usually a large meeting for consultation, exchange of information, or discussion, with a formal agenda. A conference usually occurs in hotels or convention centers with the opening event in a large hall and many short breakout sessions in various rooms and could hold for some days or weeks. This form of PD will not be ideal for the project as it will not be large enough to be a conference. The workshop model of a PD is the most appropriate for the project because it is comprised of people with shared interests and experiences who engage in intensive discussions and practical activities on a subject or project. The type of PD developed for this project is a workshop. The purpose of workshops is to bring professionals or experts together to learn from each other. In workshops, participants are actively engaged as they solve problems and learn together.

To explore this potential solution for the gaps in teacher knowledge and practice of scaffolding strategies, I searched Google Scholar, which was linked to Walden University's Library and the Education Research Complete database for relevant literature. I used keywords, combination search terms, and phrases such as *professional* *development, professional learning, effective professional development, types of professional development, workshop, workshop as professional development, evaluating programs, evaluating professional development, and evaluating workshops*. I organized the literature review according to themes by sorting existing research into the following categories: PD – definition and purpose, types of PD, workshop as PD, and evaluating PD workshop.

PD: Definition and Purpose

PD in education is the process of lifelong learning that enhances the pedagogy and professionalism of the teacher (Evans, 2019). A commitment to life-long learning is an expectation of all professionals. Some researchers said that PD is based on the different theories of learning. The PD should involve activities related to issues faced on the job for participants to learn and improve job performance. Kenney (2016) explained that PD for teachers must include the following: a central idea that teachers should learn and a strategy that would help teachers practice the idea in their classrooms.

Conversely, Kyndt, Gijbels, Grosemans, and Donche (2016) used the term professional learning interchangeably with PD because they view PD not just as a program or an event but also as a commitment to the learning process. They explained that teacher PD occurs through formal and informal learning. However, Tooley and Connally (2016) prefer to keep to the term PD and referred to PD as professional learning like seminars, workshops, and everyday learning experiences. Evans (2019) defined PD as the process of enhancing one's professionalism or at least one of the components of professionalism. Evans (2019) explained professionalism in the context of PD as what practitioners do and how they do it, what they know and understand, where and how practitioners acquire their knowledge and understanding, what kinds of attitudes practitioners hold, what codes of behavior practitioners adhere to, what purpose(s) practitioners perform, what quality of service they provide, and the level of consistency incorporated into the above list. Akiba and Liang (2016) defined PD as a learning activity organized to improve the teaching of mathematics and student learning; for example, a district-sponsored workshop. The purpose of any PD across disciplines is for improvement in job performance. The afore-mentioned PD definitions supported the choice of PD as a possible solution to the issues revealed by this case study.

Darling- Hammond et al. (2017) identified some key features that must be evident in effective PD. The PD must focus on strategies that teachers can use in their content areas in their classrooms. An effective PD must have interactive activities that will engage the teacher participants. Another critical feature of an effective PD is teacher collaboration either by grade level or by content. An effective PD must include models for effective practice to enable teachers to see the model best practice. An effective must provide coaching and expert support and allow teachers to reflect on their practices, receive feedback, and make changes to their pedagogy. Lastly, an effective PD must provide teachers time to learn new strategies, practice them, and reflect on current practices.

Types of PD

PD takes on different formats depending on the purpose or objective of the PD. The different types of PD are coaching, study groups, professional learning communities, and communities of practice. PD could be in the form of instructional coaching by an expert, usually an academic coach or teacher leader who models best teaching practice. The coaches work one-on-one with the teacher, discuss with the teacher, plan lessons with the teacher, and give the teacher feedback on what is observed. Ma, Xin, and Du (2018) suggested the model of peer coaching-based PD for 20 in-service teachers to help ease them into the profession.

Another model of PD is to have teacher study groups (TSG) that are teacher driven (Firestone, Cruz, & Rodl, 2020). TSGs unlike PLCs focus on one preselected topic over time. PLCs may focus on a range of topics chosen by the teachers in the group. TSGs meet regularly and focus on how their instruction affects students' learning. TSGs also include new content each time they meet in order to increase collective new knowledge. In contrast, PLCs function as their source of knowledge; therefore, they are grounded in the on-going practice of its members. Thus, PLCs lack connection to evidence-based instructional strategies and practice.

Communities of practice (CoP) is another form of professional development that is peculiar to teachers and other professionals in the health, government, and business sectors of the economy (Vangrieken, Meredith, Packer, & Kynd, 2017). The framework of CoP is based on social and situated learning theory, and in this type of PD, learning takes place in the actual place of practice and including a social environment. Therefore, novices and experts are included in this type of community. Members of the CoP are a group of people who share the same profession and build relationships to learn from each other. CoPs are not limited by formal structures but cut across organizational and geographical boundaries.

Workshop as PD

A workshop is a model or type of PD. The purpose of workshops is to bring professionals or experts together to learn from each other (Glowacki-Dudka et al., 2017). In workshops, the participants are actively engaged as they solve problems and learn (Svenska, 2020). Cai et al. (2019) investigated the impact of a 3-day problem-posing workshop for elementary mathematics teachers. This workshop focused on increasing the teachers' knowledge of problem posing and learning how to teach students through problem posing. The workshop had five major problem-posing activities, which allowed the participants to discuss how they would integrate problem-posing components into their lesson plans and practice problem posing. Bruni-Bossio and Delbaere (2020) used the workshop model of PD to enhance business school students' careers. The workshop's components were a practical context that all participants focused on; hands-on activities; opportunity for socialization; and opportunity for reflection.

Kuhn, Murray, Pan, Rabiner, and Sabet (2018) examined the effects of a 5-day teacher workshop that focused on social-emotional coaching and problem-solving. The workshop included several brief vignettes used for discussions, brainstorming with peers, role-plays, and small group activities such as video modeling, practice, and reflection. The teacher participants also had to create a behavior plan that would be applied in their classrooms. Malik (2016) conducted a professional learning workshop for librarians about adult learning theory, which was interactive, and the participants were given time to reflect on their learning during and at the end of the workshop. Malik (2016) concluded that it is crucial to lend a voice to the intending teacher participants in designing a PD session to avoid the one size fits all for such training.

Evaluating PD Workshop

The goals, timing, and purpose of evaluations determine the type of evaluation used for any PD/training program. Evaluations could either be formative or summative and could also be goal-based or outcome-based. Formative evaluations are conducted during the PD session to adjust the training program to meet the participants (Borg, 2018; Chyung, 2018). Conversely, summative evaluations are conducted after the PD program and after some time has elapsed to allow for the collection of observation and interview data. Goal-based evaluation is used to evaluate a PD program against the intended outcome (Chyung, 2018).

The purposes of evaluating workshops are to reflect on the workshop's quality, determine if and what the teacher participants learned, and encourage teachers to reflect on their practice and planning (Derzee, 2017). Lucas et al. (2017) proposed a systematic approach to evaluating a teacher training workshop on information and communication technology using the Analytic Hierarchy Process (AHP) decision model. The four indicators of this evaluation model were workshop design, quality of the workshop content, quality of delivery of the workshop's content, and relevance of the workshop. They further divided the four indicators into smaller components in the evaluation surveys. Thoring, Mueller, and Badke-Schaub (2020) suggested five principles for evaluating Design Science Research (DSR) workshops. The first principle is to define the research question and evaluation goals. Next, identify the roles of the stakeholders and compare data from more than one appropriate source. Then describe and publish the evaluation goals, methods, selection criteria, participants' details, workshop course, and workshop results to allow other researchers to replicate the evaluation guidelines, and lastly, provide 3-5 points on the usefulness of the evaluation procedure. They also suggested using observation data, video analysis, photography, audio, interviews, surveys, questionnaires, and focus group discussions on evaluating the workshop.

Implementation of the Scaffolding Strategies for Mathematics PD

Existing Supports and Potential Resources

The existing supports for this project are those things that are currently available to aid the implementation of the project, and the potential resources are those resources that are needed for the effective implementation of the PD; without the potential resources, the PD cannot be implemented. One of the existing supports that are available to the PD project is training rooms. There are training rooms in every high school in the district that could be the PD workshop's location. These training rooms are equipped with current technology for presentations. The facilitator would need to project the presentation via a smartboard projector. Also, the room has charging ports for laptops in case participants have to charge their laptops. Every high school also has academic coaches who work closely with teachers to improve their instruction and support them. Also available for the PD project are technology personnel from the district who can attend to any software or hardware issues teachers may have. In addition to these existing supports, there are many potential resources available online. Potential online resources are available via the internet, including online technology strategies for learning and computer programs for leveled learning and assessments. Teacher participants can practice in groups to use the various online resources and technology strategies and then decide which of them to use in their classrooms. Some of these technologies help teachers to give students feedback in real-time.

Personnel and Other Resources

The implementation of the Scaffolding Strategies for Mathematics PD project will need personnel and some other resources. An academic coach is proposed to assist with training to answer the teacher participants' questions. A technology specialist is needed to ensure the availability of the technologies to be used at the workshop. There will be an administrator to oversee the project's approval and the scheduling of the 3-day workshop. FOA teachers are invited to attend as the PD is designed to improve their scaffolding strategy use and instruction. The other resources needed for the PD project are writing materials, and presentation handouts. The facilitator will use technology like PowerPoint to show visuals that will keep participants engaged and remember the training. The participants would need writing materials to record essential details about what they learn during the workshop. The participants would also need copies of handouts to refer to during the presentations. The facilitator will provide the writing materials and handouts and will be responsible for securing and distributing them to the participants.

Roles and Responsibilities of Stakeholders

The workshop facilitator will be responsible for providing the PowerPoint presentation and relevant materials directly connected with the PPT presentation. The school district and school administration will be responsible for providing technology and technology experts. Administrators will not be expected to attend the workshop but are welcome if they choose. Concurrently, the teacher participants will be responsible for attending the workshop sessions with their laptop, ideas, and a willingness to collaborate with other teachers and learn from them. The teachers will also be responsible for completing the PD workshop's formative evaluation at the end of the workshop.

Potential Barriers and Solutions to Barriers

The proposed PD project is a 3-day workshop that will require the teacher participants to be away from the classroom for those days, thus requiring also the need for substitute teachers to cover the FOA classes. Therefore, the ideal timing would be to implement this project right before the beginning of the school year. However, when writing this section of my study, teachers in my school district are preparing to resume work three weeks before students' resume school. Teachers will be trained on the new virtual learning protocols and so planning the 3-day workshop will be unlikely. Potential solutions include holding the 3-day workshop during the summer break, next semester's pre-planning before students resume classes, or stagger six teacher workdays and have each day's sessions on teacher workdays when the students will be in school for half a day. Having the workshop during pre-planning is ideal and will serve more teachers in the district instead of holding it during the school year. With the current virtual instruction situation becoming the new normal, the PD could be delivered.

Proposal for Implementation and Timetable

Upon approval of the Scaffolding Strategies for Mathematics PD by the district supervisor, the school principals will decide when to implement it for their FOA teachers. Teachers will reflect on their current scaffolding practices and learn how to use fraction strips as manipulatives and fraction overlays as visuals to model fraction operations. Teachers will engage in two video analyses about activating students' prior knowledge and inappropriate teacher modeling. They will also practice creating prior-knowledge warm-up activities and participate in the role-playing practice of teacher modeling. Lastly, teachers will learn and practice new technology strategies like online breakout rooms, gaming, online workstations, and new online formative assessment tools.

3-Day PD Workshop on Scaffolding Strategies for Mathematics Plan

The project is a 3-day workshop that the teacher participants will engage in intense discussions and different activities including role playing on manipulatives, visuals, activating prior knowledge, teacher modeling, and technology. At the end of each day, participants will take formative surveys to assess their learning. At the end of the workshop, the facilitator will thank all participants and ask them to complete the workshop evaluation either on phones using QR code reader or on their laptops. A detailed agenda of the PD workshop is in the appendix section (Appendix A).

Project Evaluation Plan

Effective PD should be evaluated based on the project goals. Data must be collected during the PD and at the end of the workshop to determine the workshop's effects on the teachers' performance. The purpose of PD is to increase the quality of teachers' content knowledge and pedagogy. The goals of this project are: First, teachers will be able to demonstrate increased knowledge of scaffolding strategies via self-reflection in the formative assessment at the end of the workshop. Secondly, teachers will describe how they plan to incorporate all the scaffolding strategies that they learned in their classroom instruction. Evidence of this will be in the project evaluation at the end of the workshop.

Effective PD positively impacts teachers' attitudes and beliefs (Merchie, Tuytens, Devos, & Vanderlinde, 2018). In planning an evaluation for this PD, one must give careful thought to the type of evaluation, whether goal-based, outcome-based, formative, or summative. The purpose of the review and the evaluation's timing help determine which type of evaluation to consider for the Scaffolding Strategies for Mathematics PD/training, a 3-day workshop. The evaluation aims to determine whether the PD workshop goals were accomplished; therefore, the evaluation that will be considered for this project is formative. Formative evaluations are usually given during the PD program. A formative evaluation will be used for this PD workshop. Therefore, participants will complete evaluation surveys at the end of each day of the workshop. The information gathered will be used to make necessary changes to the PD to improve teachers' scaffolding strategies' delivery or content. On the last day of the workshop, the teacher participants will take a self-evaluation of what they have about scaffolding strategies during the 3-day workshop and how they will use them in their classroom.

Project Implications

The Scaffolding Strategies for Mathematics project is a PD workshop designed to address the gaps in the FOA teachers' knowledge and practice of scaffolding strategies. This project aims to fill gaps in knowledge and practice by the teacher participants of scaffolding strategies. The school district's mathematics supervisor will deliver this PD and target the FOA teachers in the school district. The PD may promote a positive social change by deepening FOA teachers' understanding of scaffolding and providing them opportunities to learn and practice new and current scaffolding strategies. The FOA teachers may improve their pedagogy, and students may benefit from the improved instruction of their teachers by increasing their learning and achievement. The aforementioned project implications may result in FOA students performing better in subsequent mathematics classes.

Conclusion

Scaffolding Strategies for Mathematics is a PD session that was created based on the findings of this study described in Section 2 and recommendations in current literature. The outcomes of this project study showed that 82% of the participants did not mention manipulatives, 45% did not mention visuals, 91% did not mention teacher modeling, and 55% did not mention technology as part of their scaffolding strategies. During my classroom observations, 89% of the participants did not activate prior knowledge, 89% did not use manipulatives, 56% did not use visuals and teacher modeling to scaffold their students' learning. Lastly, 67% of the participants did not include manipulatives in their lesson plans. Therefore, PD is targeted at the FOA teachers to fill those gaps in the knowledge and practice of scaffolding. Implementation of the 3-day workshop PD will occur at an agreed time during the school year upon the school district's approval.

Section 4: Reflections and Conclusion

In this qualitative case study, I explored how FAO teachers described their scaffolding strategies and scaffolded their students' learning. In this section, I present my reflections on the study, the project, and my learning and growth as a scholar.

Project Strengths and Limitations

The proposed PD session is a 3-day workshop that is designed primarily for FOA teachers to address gaps in knowledge and practice of scaffolding strategies as revealed by the results of the project study. By attending this workshop, teachers will be exposed to intense collaboration on scaffolding activities and opportunities to practice scaffolding strategies that they may not have practiced in their classrooms. The attendees will be primarily FOA teachers and any other mathematics teacher who is interested in learning more about how to scaffold the learning of their students. Teachers can implement these strategies and compare experiences in their PLCs even after the workshop. This process will ensure the continuous improvement of the quality of FOA teachers’ pedagogy. PD sessions offer teachers the opportunity to clarify their understanding of scaffolding and scaffolding strategies. PD sessions also offer teachers the opportunity to practice one scaffolding strategy. Another strength of the PD session is that it offers teachers opportunities to learn technology instructional strategies and online formative assessment tools. One limitation of this project is its timeframe; it is a 3-day workshop. There is no follow-up PD to determine whether teachers have implemented the strategies taught. Future research can expand on the PD and make it 3 to 6 months of professional learning that will be summatively evaluated.

Recommendations for Alternative Approaches

The rationale for this study was that an increasing number of FOA students in a local high school A were failing the FOA course; hence, they were not prepared for Algebra 1. An alternative approach to this problem could be to examine how FOA students perceive their self-efficacy in mathematics. According to Riskiningtyas and Wangid (2019), self-efficacy is a capability that is needed by students in mathematics. Self-efficacy is the belief in one's capabilities to accomplish a task. It is easier for students with strong self-efficacy in any subject area to participate in any given task related to strong self-efficacy. Self-efficacy is, therefore, very important in mathematics as it positively influences student achievement; therefore, the subject teachers must find a way to develop their students' self-efficacy. An alternative definition of the problem would be the low students' self-efficacy in mathematics and exploring ways to increase students' mathematics self-efficacy to improve FOA student achievement. The middle grades (6-8) are critical for students' mathematics and science learning and achievement, as the middle-grade content is the foundational support or pre-requisites for effective learning and instruction for ninth-grade standards (Lee, Hayes, Seitz, DiStefano, & O'Connor, 2016).

Another approach to address this problem is to examine how FOA teachers perceive their students' self-efficacy in mathematics. Fundamentally, FOA teachers must have correct perceptions of their students' self-efficacy to understand that there is a problem and then try to solve it via the proposed study. Lastly, another approach to address this problem could be to examine FOA teachers' self-efficacy in terms of teaching FOA. According to Gonzalez, Peters, Orange, and Grigsby (2017), the stronger the teachers' self-efficacy, the higher the teacher-morale and a reduced teacher burn-out. High teacher self-efficacy, as measured by self-efficacy on teacher surveys, positively impacts student achievement, student motivation, and student self-efficacy. Students with strong self-efficacy have an equally strong belief and confidence that they can accomplish difficult tasks and succeed in their academics.

Scholarship

While researching this project study, I expanded and deepened my knowledge of academic research. Before enrolling in Walden University's Doctor of Education program, I conducted an autoethnography for my master's degree, so I had a reasonable idea of what to expect in my doctoral degree pursuit. I was drawn to qualitative studies because of my personal experiences and curiosity to know more about issues. I have increased my knowledge of qualitative studies with the help, guidance, and support of my Walden University professors. I also was improving my pedagogy as I progressed in this program and learned about scaffolding strategies. This study provided insight into how FOA teachers described their scaffolding strategies and how they scaffold their students' learning.

Project Development

While writing Section 3, I knew that I had to develop a project based on the outcomes of the project study. I then began reading scholarly articles on PD as this seemed to be the most appropriate way to address the gaps in practice revealed in the study's findings. I researched PD and learned that there were several PD genres such as seminars, conferences, workshops, and networks. I then researched workshops because I had experienced workshops and that was the type of PD that would be most appropriate to address gaps in knowledge and practice involving scaffolding strategies. I learned about the various forms of PD and adult learning theories that guided the development of the PD project. I also learned about the different types of evaluations for PD. These types of evaluations are determined in terms of time in which it is offered, PD focus, intended users, intended use, needs of stakeholders, and needs of the organization (Chyung, 2018). I planned and developed the project by first identifying specific gaps in knowledge and practice of the FOA teacher participants regarding their scaffolding strategies, I then created PowerPoint slides for the PD to create lesson plans and decide what resources will be needed for this PD.

Professional Growth

I have learned much on this doctoral journey. I have improved my teaching craft, and I look forward to continuing lifelong learning and inspiring students to love learning. I have learned about developing a PD workshop, various instructional methods, and forms of assessments. I have also learned about lessons in leadership which I currently practice. I am more willing to try more evidence-based instructional strategies as I learn from research, PD sessions, and colleagues. I have learned about PD and developed an interest in building mathematics curriculum. I have improved my critical thinking skills and am more analytical in terms of my thinking. My writing experience as a doctoral student has helped grow my writing skills with the help and guidance of my chair and professors at Walden University.

Reflection on the Importance of the Work

There were gaps in terms of the knowledge FOA teacher participants of what scaffolding is and what can be described as scaffolding strategies. The FOA teacher participants were asked about how they support students' mathematics academic achievement through scaffolding instructional strategies. The problem of this project study was that the district educators knew little about the scaffolding strategies of FOA teachers. The study's findings gave insight into how FOA teachers described their scaffolding strategies and scaffold their students' learning. Since the inception of the FOA course, no study has been conducted to investigate the instructional strategies of FOA teachers. The study's outcomes were the basis of the development of a 3-day workshop to address gaps in knowledge and practice of FOA teachers involving scaffolding strategies. This will serve as a template for similar PD sessions that can be implemented in other schools.

Implications

Social Change

Findings from this study contributed to addressing a problem among high schools that the district educators knew little about the scaffolding strategies of FOA teachers. The study findings and proposed project could improve their scaffolding skills and increase the learning of FOA students in the district. If there is a widespread problem in high schools of an increasing number of FOA students failing the FOA course, then a closer look must be taken into the plausible causes, one of which could be ineffective instruction by the FOA teachers. A PD like the one designed in this project would then be developed to address the gaps in the knowledge and practice of FOA teachers' scaffolding strategies. Both the academic coaches in each high school or the district's mathematics supervisor could deliver the PD, targeted for FOA teachers. The PD may promote a positive social change by deepening FOA teachers' understanding of scaffolding and provide them opportunities to learn and practice new and current scaffolding strategies. The PD's possible outcomes are improved FOA teachers' pedagogy and increased student learning and achievement. This positive social change may translate to the FOA students performing better in subsequent mathematics courses. The FOA students would have acquired a stronger foundation for their mathematics learning, which would make them better prepared for Algebra 1.

Recommendations for Future Research

This study's potential benefits may be the basis of similar studies in other high schools in the district. The project study results revealed the need for FOA teachers to understand better scaffolding and how to scaffold their students' learning. Therefore, I recommend that similar qualitative case studies be conducted in other high schools in other school districts. A purposeful sample of FOA teachers in the schools would be the proposed participants.

Applications

The Scaffolding Strategies for Mathematics PD could be adapted for other high schools in other school districts. Therefore, I recommend the training program for other high schools. A survey could be conducted before implementing this PD in other schools to determine what scaffolding strategies the FOA teachers currently use. Then a time frame for the PD would be scheduled by the school's mathematics administrator.

Conclusion

Through this qualitative case study, using interviews, classroom observations, and review of teachers' lesson plans, I examined how FOA teachers described their scaffolding strategies and how they scaffolded their ninth-grade students' learning. The findings showed gaps in teachers' knowledge and practice of scaffolding in manipulatives, visuals, activating prior knowledge, teacher modeling, and technology. A 3-day PD was designed based on the study results to meet the FOA teachers' needs to improve their scaffolding skills and increase students' learning. Just as any building's foundation is critical to its existence, it is crucial to invest in building the FOA students' mathematical foundations for high school mathematics courses and mathematics-related careers. The Scaffolding Strategies for Mathematics PD includes opportunities for FOA teachers to acquire more knowledge about scaffolding and improve their instructional skills to benefit their students. The FOA teachers will, therefore, develop as agents of social change.

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Appendix A: The Project

I will present this project to the supervisor of mathematics in my school district. The findings from this study of how FOA teachers describe their scaffolding strategies and how they scaffold their students' learning indicated specific needs for writing professional development. Using the study findings and recommendations from professional development literature, I have developed a professional development for scaffolding strategies. The following documents and presentations comprise the proposed professional development and details regarding its implementation. The four attachments include the following:

- Scaffolding Strategies Used by FOA Teachers.pptx: a PowerPoint presentation that includes an overview of the findings of this study and the proposed project to address FOA teachers' instructional needs;
- Scaffolding Strategies for Mathematics.docx: a narrative description of the proposed professional development workshop, including itemized lists of the PD workshop and details of the implementation;
- Supplement 1.docx: instructional plans for the professional development/training sessions; and
- Supplement 2.docx: Scaffolding Strategies for Mathematics Professional Development evaluation surveys for mathematics teachers attending the training sessions.

The district mathematics supervisor, school principals, mathematics school administrators, and FOA teachers, please review the materials and consider implementing the Scaffolding Strategies for Mathematics Professional Development. It will be my delight to answer any questions you may have concerning the study or professional development.

Introductory PowerPoint Presentation

Scaffolding Strategies by Foundations of Algebra (FOA) Teachers
A Project Study
Pauline O. Aikhuele, ED.D, CIA

Project Study Overview

The project is a professional development (PD) workshop for FOA teachers. The purpose of the PD is to address the gaps in the knowledge and practice of Scaffolding strategies in the FOA teachers, as revealed in the project study.

This PD is a 3-day workshop that will afford the FOA teachers the opportunities to share and compare their current Scaffolding strategies and learn new strategies.

The workshop will be filled with brainstorming sessions, role-playing practices, and new technology strategies.

The themes for the three days are: Using Manipulatives, visuals, activating prior knowledge, teacher modeling, and technology for Scaffolding.

Research Findings

IMAGE HIDDEN
(Interview, observation, and documents)

Note. All visible images are public domain unless otherwise indicated.

Data collected from 11 Teacher participants via interviews; from 9 Teacher participants via observations and lesson plan documents indicated specific gaps in perception and practice. Two major themes and five sub-themes emerged from the data analysis. The subthemes are activating prior knowledge, socratic questioning, student grouping for learning and collaboration, technology, and these were grouped as one subtheme - paces the lesson, manipulatives, visuals, and teacher modeling.

The two major themes are instructional strategies and positive learning environment. Findings from the interview data showed that less than 100% of the teachers interviewed did not consider manipulatives, visuals, teacher modeling, and technology as part of their scaffolding strategies. Findings from both observation and lesson plan data indicated that less than 100% of the teachers did not use the following approach to scaffold the students' learning – activating prior knowledge, manipulatives, visuals, and teacher modeling.

Professional Development

Scaffolding Strategies for Mathematics

Scaffolding Strategies for Mathematics

Scaffolding Strategies for Mathematics professional development is a 3-day workshop designed primarily for FOA teachers and other mathematics teachers who feel the need to sharpen their Scaffolding skills.

Scaffolding Strategies for Mathematics Goals

The primary goal of the Scaffolding Strategies for Mathematics Workshop is to improve the teaching practice of the FOA teachers in the following areas:

- Activating prior knowledge
- Manipulatives
- Visuals
- Teacher modeling, and
- Technology

Professional Development Workshop Program

- Day 1:
  - Discussion on Scaffolding – theories, challenges and benefits
  - Lesson on Fractions using manipulatives and visuals
- Day 2:
  - Discussion on activating prior knowledge with opportunity to create prior-knowledge warm-up activities
  - Opportunities for participants to model instruction
- Day 3: Collaboration on various technology tools and learning how to use them in the classroom

Scaffolding Strategies for Mathematics

Materials for the professional development workshop:

- Fraction strips
- Worksheet on Exploring Fraction of Fractions
- Fractions think-map
- Fraction overlays – Muliplifractions
- List of activating strategies
- Prior-knowledge activities template
- List of video links and technology tool links

Scaffolding Strategies for Mathematics Professional Development/Training

The Scaffolding Strategies for Mathematics is a 3-day professional development designed to serve FOA teachers primarily to improve their Scaffolding skills. The type of professional development chosen for the PD is a workshop. The purpose of this workshop is to broaden the knowledge of FOA teachers about scaffolding strategies for them to scaffold the learning of their ninth-grade students better. Other mathematics teachers who feel the need to improve their instructional skills regarding scaffolding can also participate in the professional development workshop. The 3-day program for the Scaffolding Strategies for Mathematics is as follows:

Day 1: Scaffolding Strategies for Mathematics Agenda

Time	Activity

8:00am - 8:30am (30 minutes)	**<u>Welcome, Introduction, & Energizer</u>**
	• **Introduction of presenter(s)**
	• **State the session's learning target(s)**
	    ○ Describe scaffolding strategies
	    ○ Describe how to scaffold the learning of students
	• **Review professional learning expectations**
	    ○ Be actively engaged in all the sessions with no distractions.
	    ○ Be ready to share experiences and learn from others.
	    ○ Be positive and determined to practice one scaffolding strategy that you have never used in your classroom.
	
	• **PD Workshop Energizer:** Getting to Know You
	    ○ As music plays for 2 minutes, you will walk around and find someone you do not know and introduce yourself to that person and tell 3 things about yourself.
	    ○ When the bell ringer goes off, walk to another person, introduce yourself and tell 3 different things about yourself. You cannot repeat the information you shared in round one.
	    ○ You will do this exercise for three rounds.

<table>
<tr><td>8:30am - 9:30am (60 minutes)</td><td><u>Scaffolding and Scaffolding Strategies</u>

Why Scaffold in Foundations of Algebra?

Participants turn and talk to each other at tables about their thoughts on the reasons for scaffolding in mathematics.

What is Scaffolding in Mathematics?

Participants turn and talk to each other at tables about their thoughts on scaffolding in mathematics.
Listen to responses from each table
Presenter: Use an online collaboration forum like Kahhot.it, Nearpod.com or Padlet for participants to share responses. Lead discussion based on responses leading to formal definition of scaffolding.

Understanding Scaffolding Theory

Bruner’s constructivist theory explained
Vygotsky’s zone of proximal development explained.

Challenges and Benefits of Scaffolding

Table group discussion: What are your challenges in using scaffolding strategies in your classroom?
What benefits have you observed in using scaffolding strategies?
Each table share out one challenge and benefit of scaffolding strategy
Facilitator will share with participants a list of challenges and benefits of scaffolding and have a whole group discussion.

</td></tr>
<tr><td>9:30am – 10:15am (45 minutes)</td><td><u>Scaffolding Strategies</u>

Participants will discuss each scaffolding strategy

Participants: How should each strategy be implemented?
Which of the strategies have you used in your classroom?
Are there anyone scaffolding strategies you have used that are not on the list of scaffolding strategies?
Presenter: Use an online collaboration forum like Kahhot.it, Nearpod.com or Padlet for participants to share responses. Lead discussion based on responses.

Classroom Examples

Teacher participants will share examples of the scaffolding strategies they have used in their classrooms.
If available, pictures or videos of these examples will be shown electronically.

</td></tr>
<tr><td>10:15am – 10:25am (10 minutes)</td><td><u>Break</u>

Snacks and Drinks will be provided for participants
</td></tr>
</table>

10:25am - 11:25am (60 minutes)	**<u>Manipulatives</u>**
	• **Facilitator will share learning target for this section of the PD.**
	  o Use fraction strips and regional model manipulatives to deepen students' understanding
	• **What are some examples of manipulatives?**
	  o Participants will share what they know about manipulatives.
	  o Facilitator will reveal a list of manipulatives on the Power Point presentation.
	• **Modelling with Manipulatives**
	  o Facilitator will model teaching a lesson on multiplying fractions.
	  o What is the prior knowledge for this lesson? Participants will list the required prior knowledge skills.

11:25am – 11:55am (30 minutes)	• **Teacher Collaboration:** o Teachers will collaborate on how to implement the scaffolding strategy of using manipulatives in their next lesson. Each table will create a poster after lunch.
11:55am - 12:50pm (55 minutes)	**<u>Lunch</u>** • **Options:** Lunch will be provided by the school district.

12:50pm – 12:55pm (5 minutes)
 	
12:55 – 1:55 pm (60 minutes)
	<u>PM Session Energizer</u>
	• As music plays for 5 minutes, you will walk around and find someone you do not know and introduce yourself to that person and tell what you have learned in the morning sessions.
	• When the bell ringer goes off, you will go back to your seats.
	• **Teacher Collaboration (Cont'd):**
	  o Teachers will collaborate to create a poster of a lesson plan that incorporates the use of manipulatives. The posters will be pasted around the room.
	  o Teachers will do a gallery-walk to read and learn ideas from the lesson plans on the posters.
	• **Role Playing**
	  o Each team will present a role-playing skit that will demonstrate using manipulatives to scaffold students' learning.
	  o Debrief on the lesson plans and adjust if needed.

1:55pm-2:55pm (60 minutes)	**<u>Using Visuals for Learning</u>**
	• **Facilitator will share learning targets for this section of the PD.**
	  o Use visuals for learning in a lesson on multiplying fractions.
	• **What are some examples of visuals used in the classroom?**
	  o Participants will share what they know about visuals.
	  o Facilitator will reveal a list of visuals on the Power Point presentation.

	• **Session 2 Activity 1:**
	  ○ Participants will turn and talk with a table partner how they would model solving a set of fraction problems with a picture or diagram.
	• **Session 2 Activity 2:**
	  ○ Participants will each be given a think-map to write down their thoughts on solving two sets of problems involving multiplying fractions by another fraction.
	• **Session 2 Activity 3:**
	  ○ Participants will share their thoughts on how to use the fraction overlay visual to model multiplying fractions
	  ○ Facilitator will demonstrate "Fading" by modeling how to multiply mixed numbers using the distributive property.
	  ○ Participants will engage in working on two problems involving multiplying mixed numbers.
	  ○ **Closing:** Teacher participants will share with each other which method of multiplying mixed fractions they prefer? Then they will create a word problem and solve.

2:55pm-3:30pm (35 minutes)	<u>**Closing & Evaluations**</u> • **Closing:** Participants will discuss and share what other manipulatives and visuals could they have used for the lesson on fractions. • **Evaluations:** Facilitator will direct teacher participants to complete evaluation surveys via the link and QR code displayed on the Power Point.

Day 2: Scaffolding Strategies for Mathematics Agenda

Time	Activity

8:00am - 8:30am
(30 minutes)
	<u>**Welcome, Introduction, & Energizer**</u>
	• **Introduction of presenter(s)**
	• **State today's learning target(s)**
	  ○ Review strategies for activating prior knowledge.
	  ○ Create a prior knowledge warm-up activity.
	  ○ Define teacher modeling.
	  ○ Practice teacher modeling.
	• **Review professional learning expectations**
	  ○ Be actively engaged in all the sessions with no distractions.
	  ○ Be ready to share experiences and learn from others.

	◦ Be positive and determined to practice one scaffolding strategy that you have never used in your classroom. • **PD Workshop Energizer:** Fun Fact ◦ As the music plays for 3 minutes, you will think about a fun fact about yourself. ◦ Then post your fun fact with your names on the QR code or link displayed on the PowerPoint slide anonymously. The responses will populate on the screen without showing the names of the respondents. ◦ Going one by one, each group will guess who the person is for each fun fact. ◦ In the end, the facilitator will reveal the name of the person next to the fun fact.
8:30am - 9:30am (60 minutes)	**<u>Activating Prior Knowledge & Teacher Modeling</u>** • **How do you activate students' prior knowledge?** ◦ Participants turn and talk to each other at tables about their thoughts on activating prior knowledge of their students ◦ Facilitator will share a quote on activating prior knowledge and lead a short discussion on the quote. ◦ Facilitator will share the purpose of activating students' prior knowledge. • **A Good Example of Activating Prior Knowledge** ◦ Participants will watch a short video (2:44 minutes) about a teacher modeling activating students' prior knowledge. ◦ **Table Discussion:** Participants turn and talk to each other at tables about their observations on the video. Each table must be prepared to share at least one discussion point. • **What Are Some Strategies You Already Know?** ◦ Facilitator allows participants to share strategies for activating prior knowledge before revealing a list of strategies for activating prior knowledge. ◦ Facilitator will lead a discussion on how each of the 14 listed strategies can be used in the classroom to activate students' prior knowledge.
9:30am – 10:15am (45 minutes)	**<u>Session 1 Activity</u>** • **Prior Knowledge Warm-Up Activity**

	○ Participants will examine a Warm-Up Activity example that can be used to activate students' prior knowledge and discuss their observations at their tables. ○ Participants will choose a current standard to address for this activity. Use the Prior Knowledge Warm-Up Activities Template and create a warm-up activity that you will use to activate prior knowledge. ○ Be ready to share your activity.
10:15am – 10:25am (10 minutes)	<u>**Break**</u> • Snacks and Drinks will be provided for participants
10:25am - 11:25am (60 minutes)	<u>**Teacher Modeling**</u> • **Facilitator will share learning targets for this section of the PD.** • **What is Teacher Modeling in Mathematics? How important is Teacher Modeling as a Scaffolding Strategy?** ○ Participants will share what they know about teacher modeling. ○ Participants will watch a short video on Good or Bad Modeling? (2:26 minutes) ○ Participants will discuss with table partners their observations of the video. ○ Facilitator will share a quote on what teacher modeling is and what it is not and lead a discussion on the topic. • **Components of Teacher Modeling** ○ Facilitator will share the components of teacher modeling. ○ Participants will individually reflect on their practice to answer the question of whether they have been using this strategy or a version of the strategy.
11:25am – 11:55am (30 minutes)	• **Teacher Modeling in Practice:** ○ Facilitator will demonstrate teacher modeling with two percent/proportions problems. ○ Facilitator will inform participants to be prepared after lunch to practice teacher modeling.
11:55am - 12:50pm (55 minutes)	<u>**Lunch**</u> • **Options:** Lunch will be provided by the school district.

12:50pm – 12:55pm (5 minutes) 12:55 – 1:55 pm (60 minutes)	**<u>PM Session Energizer – Untangle Yourself</u>** ○ Facilitator will ask each group to form a circle. ○ Facilitator will ask everyone put their hands up. ○ Facilitator will give the tangling instructions: 1. With your right hand, grab someone's left hand With your left hand, grab someone's right hand You cannot grab the hands of people next to you. ○ Music plays at the background. ○ Ask the group to untangle themselves without letting the hands go, and try to form a circle • **Role Playing – Teacher Modeling** ○ Teachers will volunteer to practice teacher modeling to solve an assigned problem. Questions will be assigned to each table. ○ Each team will participate in this activity. ○ Debrief on the teacher modeling.
1:55pm-2:55pm (60 minutes)	**<u>Teacher Work Session</u>** • Teachers will collaborate with their table partners to create more Prior Knowledge Warm-up activities for their individual lessons.
2:55pm-3:30pm (35 minutes)	**<u>Closing & Evaluations</u>** • **Closing:** What have you learned about activating prior knowledge and teacher modeling? • **Evaluations:** Facilitator will direct teacher participants to complete evaluation surveys via the link and QR code displayed on the Power Point.

Day 3: Scaffolding Strategies for Mathematics Agenda

Time	Activity
8:00am - 8:30am (30 minutes)	**<u>Welcome, Introduction, & Ice Breaker</u>** • **Introduction of presenter(s)** • **State today's learning target(s)** • **Review professional learning expectations** ○ Be actively engaged in all the sessions with no distractions. ○ Be ready to share experiences and learn from others. ○ Be positive and determined to practice one scaffolding strategy that you have never used in your classroom.

<table>
<tr><td></td><td>PD Workshop Ice Breaker: “Aha-Moments”
At your table groups, state one “aha” that you had during this 3-day PD workshop.
Explain how this “aha-moment” has influenced your mindset about the scaffolding strategies presented at this workshop and what you will do differently in your classroom?</td></tr>
<tr><td>8:30am - 10:30am
(2 hours)</td><td><u>Technology Enhanced Scaffolding</u>
What is technologically enhanced scaffolding? What technology do you use in your classroom?
Participants turn and talk to each other at tables to answer the warm-up questions.
Facilitator will share what technology-enhanced scaffolding is and what it is not.
Facilitator will share a quote on technology and lead a short discussion.
Technology – Show and Share
The district technology specialist will be available on the third day to show and share some knowledge on technology tools for the classroom.
Stations will be set up around the room to show the various technology tools and strategies. The academic coach will work at the stations to explain some technology strategies that teachers can use to scaffold students’ learning.
Pick One
Table group discussion: Participants will pick one new technology tool and strategy they plan to implement in their classroom.
Participants will share their plans to use their chosen technology.
Technology Practice
Participants will practice the technology tools they chose.</td></tr>
<tr><td>10:15am – 10:25am (10 minutes)</td><td><u>Break</u>
Snacks and Drinks will be provided for participants by the school district.</td></tr>
<tr><td>10:25am - 11:55am
(90 minutes)</td><td><u>Technology Practice</u>
Participants will find other participants who are working on the same technology tools and collaborate in practicing the technology.</td></tr>
<tr><td>11:55am - 12:55pm</td><td><u>Lunch</u> Options: Participants may choose to bring their own lunch or have lunch in nearby eating house.</td></tr>
</table>

(1 hour)	
12:55 – 2:55 (2 hours)	**<u>PM Technology Practice</u>** • Participants will continue to collaborate and practice more technology tools. • Incorporate new technologies and strategies into lesson plans for the week ahead.
2:55pm-3:30pm (35 minutes)	**<u>Closing & Evaluations</u>** • **Closing:** Participants will share what they have learned about technology enhanced scaffolding. • **Evaluations:** Facilitator will direct teacher participants to complete evaluation surveys via the link and QR code displayed on the Power Point.

The primary goal of the Scaffolding Strategies for Mathematics Workshop is to improve the teaching practice of the FOA teachers in the following areas: activating prior knowledge, manipulatives, visuals, teacher modeling, and technology. The implementation of this professional development/training workshop should improve the ways FOA teachers scaffold their students' learning and therefore increase the performance of FOA students. The professional development workshop's attached resources include fraction strips, a worksheet on Exploring Fraction of Fractions, fractions think-map, fraction overlays – Muliplifractions, a list of activating strategies, a prior-knowledge activities template, and a list of video links and technology tool links.

Supplement 1: Professional Development Instructional Plan

Scaffolding Strategies for Mathematics

Methodology: This professional development is a workshop; therefore, the workshop sessions will include lessons and scaffolding strategies that are demonstrated; times for teachers to work collaboratively together, create scaffolding materials for use in classrooms, opportunities to practice the scaffolding strategies in role-play situations, and opportunities to work with academic coaches and technology experts.

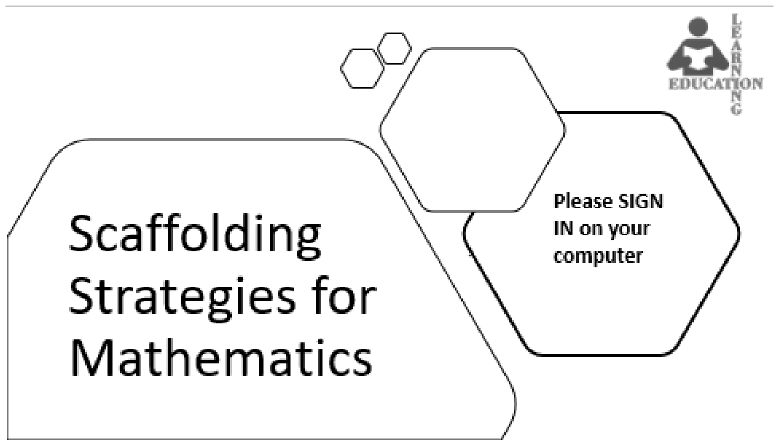
Materials: Sheets of paper, pencils, colored pencils, pens, handouts of the PowerPoint presentation, and teacher laptops.

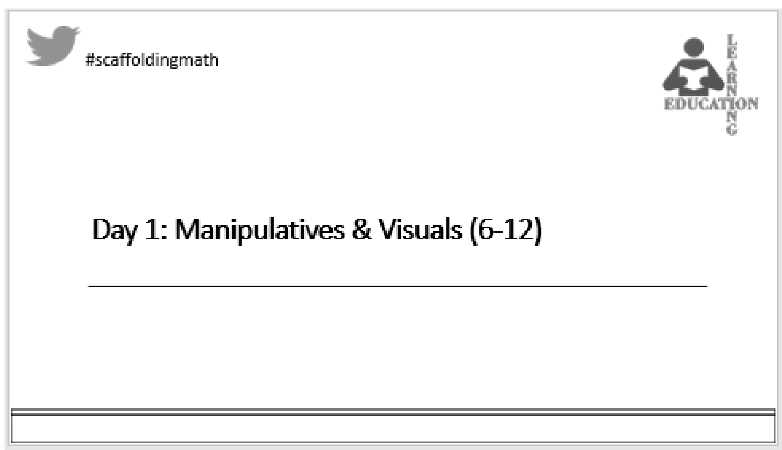
Objectives: By the end of the 3-day professional development workshop, teacher participants will have gained better understanding of

1. Scaffolding and Scaffolding strategies;
2. Manipulatives and visuals and how to use them to scaffold their students' learning;
3. How to plan for and activate students' prior knowledge;
4. How to model instruction; and
5. Different technology-enhanced Scaffolds.

PowerPoint Presentation

Note. All visible images are public domain unless otherwise indicated.





Learning Targets

1. I CAN DESCRIBE SCAFFOLDING STRATEGIES
2. I CAN SCAFFOLD THE LEARNING OF MY STUDENTS.

Professional Learning Expectations

- ❑ Be actively engaged in all the sessions with no distractions.
- ❑ Be ready to share experiences and learn from others.
- ❑ Be positive and determined to practice one scaffolding strategy that you have never used in your classroom.

PD Workshop Energizer: Getting to Know You

- As music plays for 2 minutes, you will walk around and find some one you do not know and introduce yourself to that person and tell 3 things about yourself.
- When the bell ringer goes off, walk to another person, introduce yourself and tell 3 different things about yourself. You cannot repeat the information you shared in round one.
- You will do this exercise for three rounds.

10 Minutes

Session 1
Warming/Opening

What is Scaffolding in Math?

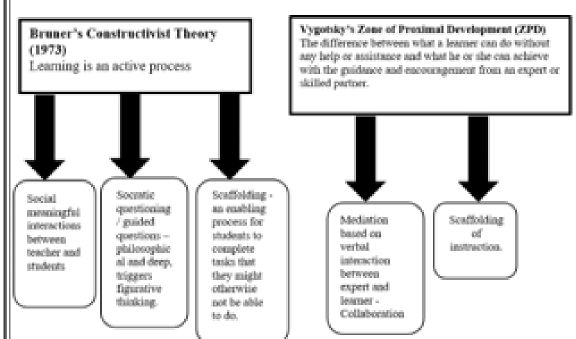
Scaffolding in Mathematics – Understanding the Theory

Session 1

"I Do, We Do, You Do" Instructional Framework

Figure 2

Conceptual Framework



Scaffolding: Challenges & Benefits

- Could be time-consuming
- Possibility of underestimating the zone of proximal development (ZPD)
- Insufficient modeling by the teacher as a result of not fully comprehending student's interests, needs, and abilities
- Teachers must be appropriately trained to scaffold instruction
- Gradual release of control for fading to occur

- Teacher could identify giftedness early
- Scaffolding provides individualized instruction
- Increases students' self-efficacy and confidence
- Differentiation happens 'naturally.' Promotes efficiency – the time is maximized, students on task and learn
- Students are more engaged
- Students are more motivated to learn
- Students experience reduced levels of frustration in the learning process

Session 1

Scaffolding Strategies

Activating prior knowledge - Using different strategies to activate and connect prior knowledge to new knowledge for the purpose of problem solving

Socratic questioning - Questioning based on the practice of disciplined, thoughtful dialogue to provoke critical thinking

Pacing the lesson - Method of organizing lessons in such a way that the teacher makes the most use of the lesson period to accomplish the lesson target(s)

Teacher modeling - The teacher demonstrating problem solving while verbalizing the process needed to solve the problem

Session 1

Scaffolding Strategies

Manipulatives - Physical tools of teaching that engage students visually and physically to aid their learning

Visuals - Imagery that helps to actively engage the learner, making it easier for the learner to recall the content.

Grouping for cooperative learning - A process where students progress individually in acquiring knowledge while working with group members towards a common goal.

Technology - games, digital field trips, integrating social media, using technology for student feedback, teachers' PPTs and Smart Notebook, sharing a class calendar electronically, including videos and multimedia, and online workstations in the classroom.

Session 1

Session 1 - Activity 1 Manipulatives

Learning Targets

- Use fraction strips manipulatives to deepen understanding of fractions
- Record in words the actions and results of finding a fraction of a fraction.
- Solve problems involving finding a fraction of a fraction, using a regional model.

Session 1 - Manipulatives

What are some examples of manipulatives?

IMAGES HIDDEN
(picture examples of manipulatives)

Modeling with Manipulatives – Multiplying Fractions

What are the prior knowledge for this lesson?

1. Basic multiplication and division facts
2. Equivalent fractions

Consider these scenarios. Use your Fraction Strips

10 minutes

1. There are 33 children in Edward's class. She was asked how many would be in her team if it included 1/3 of the class. She said 12. Is she right?
2. 15 students in Hill's class were sitting on the mat. This was 3/5 of the class. How many students are in Hill's class?
3. 18 students in Oliver's class are on the mat. 2/5 are yet to come into the classroom. How many are outside?

Defend your solutions – Finding Fractions of Whole Numbers

EDWARD'S CLASS: 1/3 OF 33 IS:

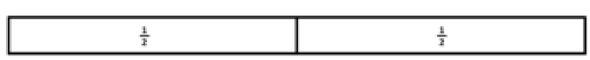
HILL'S CLASS: 3/5 OF SOMETHING IS 15 SO 5/5 IS:

OLIVER'S CLASS: 3/5 OF SOMETHING IS 18 SO 2/5 IS:

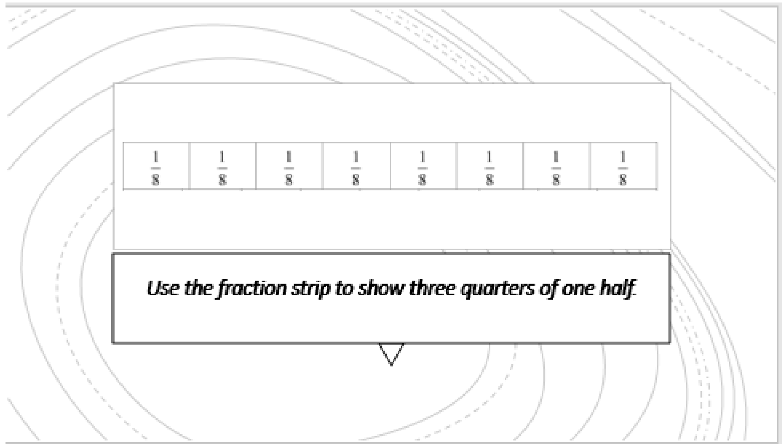
Session 1 Activity 2

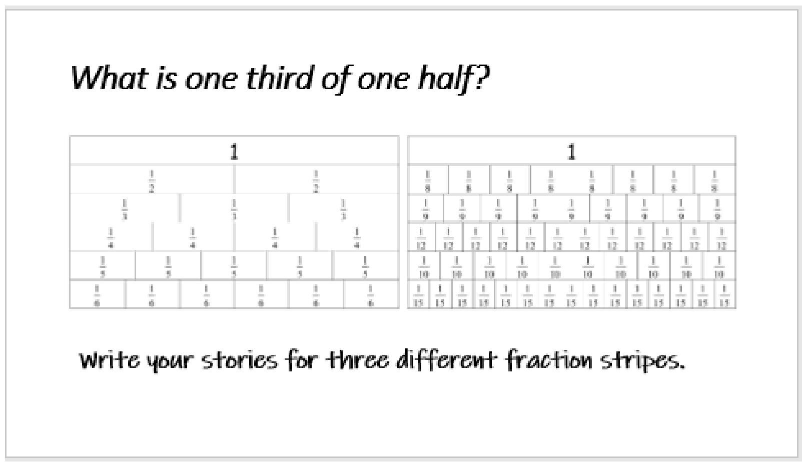
3 minutes

- *What if you find a fraction of a fraction. Will the result be larger or smaller than both fractions?* Discuss.



Can you use the fraction strip to show one half of one half?





Pair share and check your results.

Multiplying fractions: Exploring fractions of fractions

Fraction problem	Show and write the result	A story problem
What is half of one half?	One quarter	Half of the class was in the classroom. Half of this group were using the computers. What fraction of the whole class was working on the computers?
What is one quarter of one half?		

10 minutes

Session I – Activity 3

- One third of one half is one sixth, so what is two thirds of one half?
- One fifth of one half is one tenth, so what is three fifths of one half?
- One third of one third is one ninth, so what is two thirds of one third?
- One quarter of one half is one eighth, so what is three quarters of one half?

Conclusion: We can therefore conclude that a fraction of a fraction results in ______________________________.

Session 2 - Activity 1

Visuals

- Using visuals for learning
- Understand that the language 'of ' and 'times' is interchangeable
- Use arrays to model and solve multiplication equations that involve subdividing the unit

Session 2 - Visuals

What are some examples of visuals?

____

IMAGES HIDDEN (picture examples of visuals)

Session 2 Activity 1

Talk with your table partner how you would model with pictures or diagrams

1. *1/4 x 2 = ?*
2. *2/3 x 12 = ?*

Turn and TALK

Session 2 Activity 2: Explore fractions of fractions

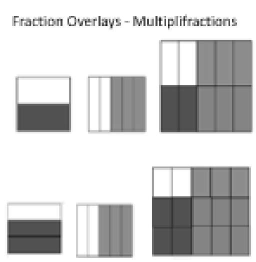
IMAGES HIDDEN (picture of solutions)

On your own, complete the Fractions think map sheet for the each of the following problems:

1. *2/3 x 9/10 = ?*
2. *1/2 of 4/9 = ?*

Discuss your think map with your table partner

Turn and TALK



Session 2 Activity 3: Modeling fractions of fractions

Take 2 minutes to explore this visual – Fraction Overlays - and how you can use it to model multiplication of fractions.

Turn and TALK

Using Multiplifractions to Multiply Fractions

Use the multiplifractions to multiply the following:

1. 3/5 x 3/4 = ?
2. 2/3 x 2/5 = ?
3. 1/5 x 1/4 = ?
4. 5/6 x 1/2 = ?

Conclusion:

- *When we are multiplying whole numbers the product is*________________ __________________________________.
- *When we multiply fractions the product is* __________________________ ____

Session 3 - Activity 1

Fading

- Work with and show understanding of multiplication involving mixed numerals, that is, fractions greater than one, for example, 1/2 of 2 2/3.
- Recognize that mixed numeral fraction multiplication problems can be solved by changing both to improper fractions or by applying the distributive property.

Multiplying with Mixed Fractions

- *"Michael has 2 1/2 spare cans of paint left over from painting his house. He uses 3/4 of this to paint his shed. How many cans is this?"*
- Explore the problem with your table partner and solve the problem.

Two Ways to Multiply Mixed Fractions

- $2\frac{1}{2} \times \frac{3}{4}$
- Using the distributive property, or;
- Changing the mixed numeral into an improper fraction.

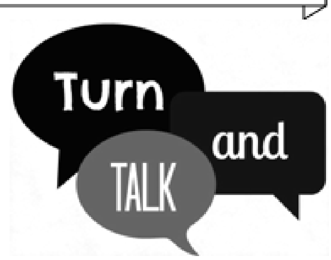
Activity 2 - Work in Pairs on This

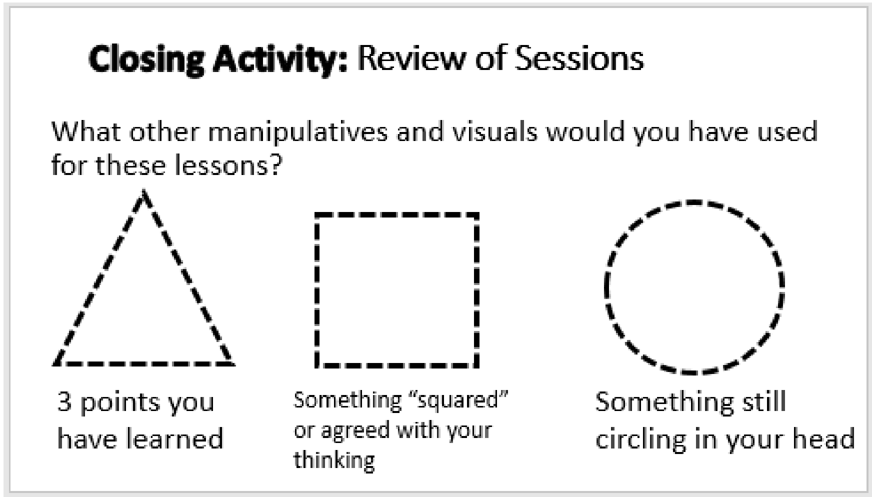
1. *Alyssa has 3 1/3 meters of fabric. She uses 2/3 of this to make her dress for the school Prom. How many meters did she use?*
2. *The floor area of Donte's bedroom is 8 1/4 square meters. 3/4 of this is taken up with furniture. How many square meters of spare floor space does he have?*

Activity 3 - Which Method Do You Prefer?

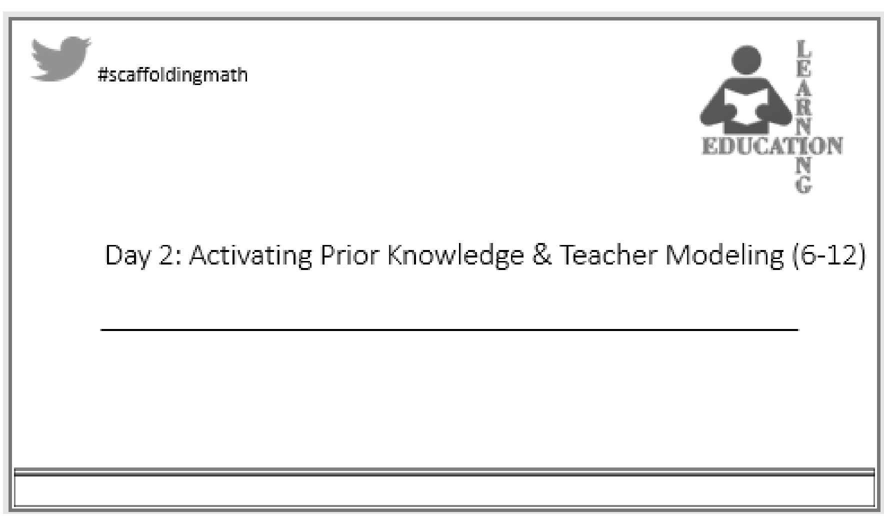
- Changing both to improper fractions, or
- Applying the distributive property

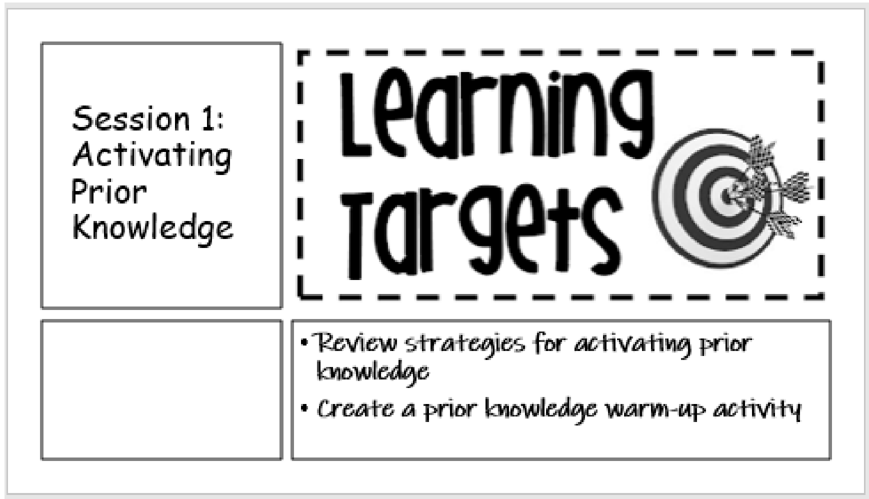
Talk with your table partner and create your word problem with mixed fractions and then solve it.

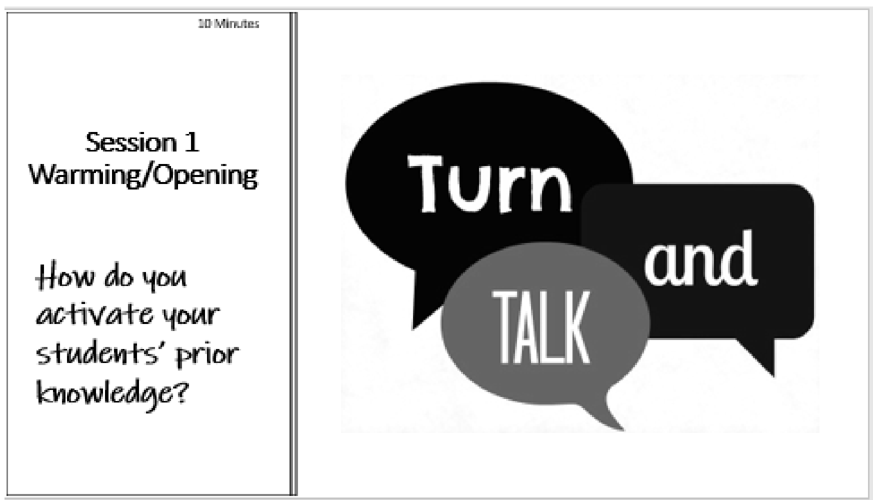


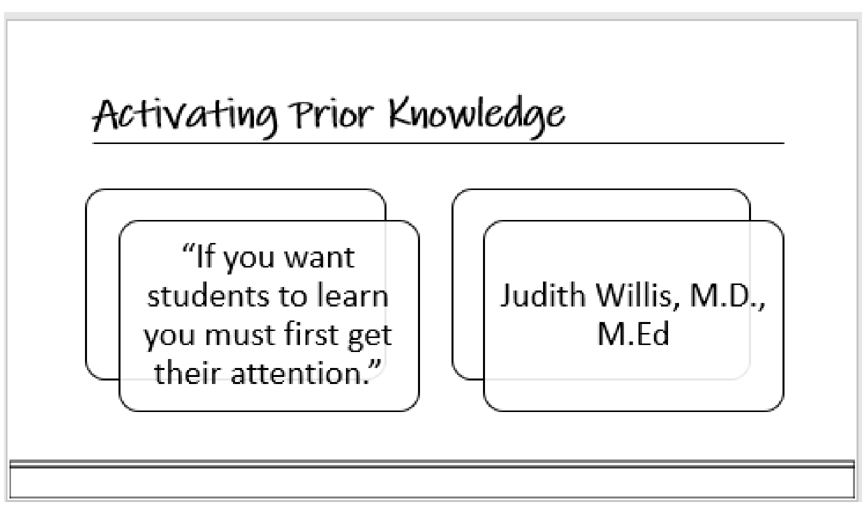

Closing Activity: Review of Sessions
What other manipulatives and visuals would you have used for these lessons?
3 points you have learned
Something "squared" or agreed with your thinking
Something still circling in your head


Kindly take the survey


#scaffoldingmath
EDUCATION
LEARNING
Day 2: Activating Prior Knowledge & Teacher Modeling (6-12)


Session 1:
Activating
Prior
Knowledge
Learning
Targets
• Review strategies for activating prior knowledge
• Create a prior knowledge warm-up activity


10 Minutes
Session 1
Warming/Opening
How do you activate your students' prior knowledge?
Turn
and
TALK


Activating Prior Knowledge
"If you want students to learn you must first get their attention."
Judith Willis, M.D., M.Ed

Purpose of Activating Prior Knowledge

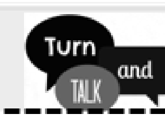
Activating students' prior knowledge involves:

1) **linking** new learning to what they may already know, and

2) **build** background knowledge by creating unique experiences for them.

How did Adrienne King activating her students' prior knowledge?

What are some strategies you already know for activating prior knowledge?



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(List of Scaffolding Strategies)

How can we use these in a Math Class?

1. Image Brainstorm
2. K-W-L Chart.
3. Word Splash
4. Anticipation Guide
5. Think-Pair-Share
6. Gallery Walk or Walking Tour
7. Picture Postcard
8. Draw Picture or Diagram
9. Activating Acrostic
10. Dear Teacher
11. 3-2-1
12. Treasure Hunt – Find Someone Who Can Tell
13. Five Words – Three Words
14. In the Hot Seat

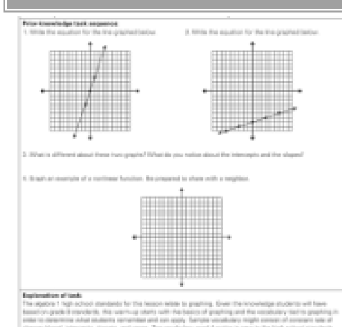
Turn and TALK

Examine this Example with Your Table Partner

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard From Prior Grade, Course, or Unit
Algebra 1	**Formal unit standard:** • Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). • Graph linear functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. **Essential learning standard:** I can graph linear and nonlinear functions. **Daily learning target:** • Students will be able to graph different functions by hand. • Students will be able to distinguish between linear and nonlinear functions.	**Grade 8:** • Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. • Derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.

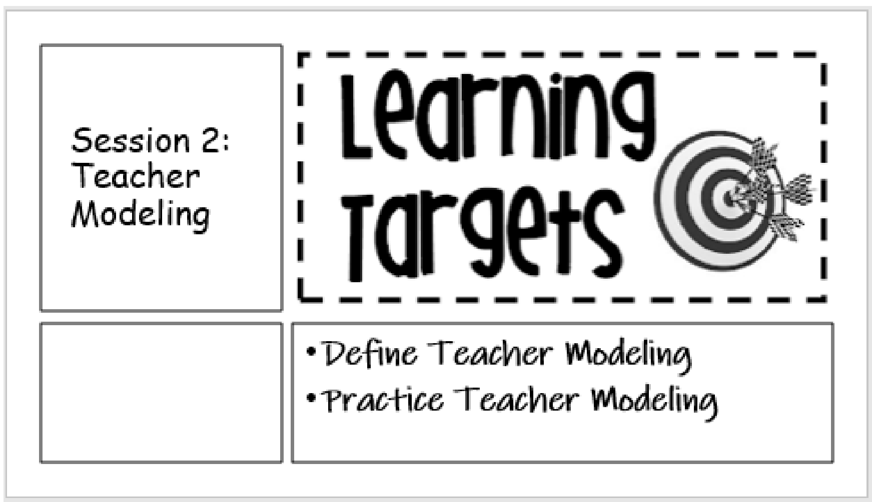
Turn and TALK

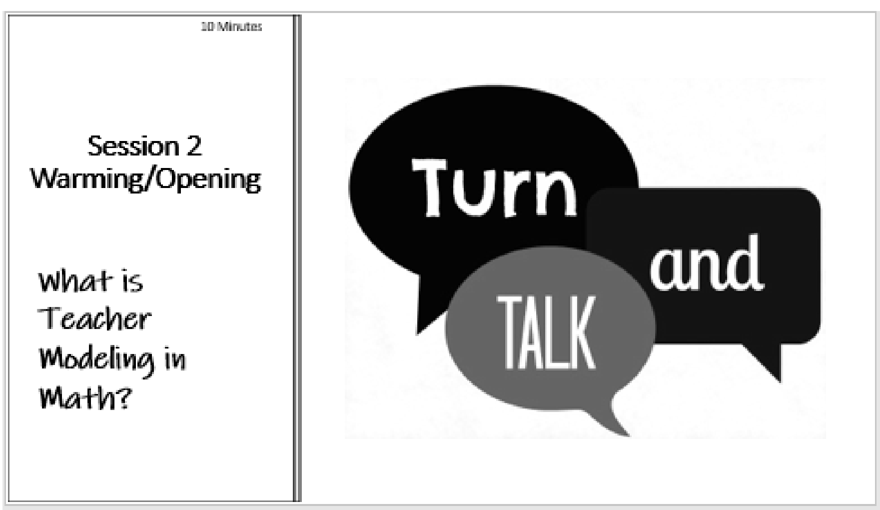
Examine this Example with Your Table Partner



Turn and TALK


Turn and TALK
Session 1 Activity 1
15 minutes
• Choose a current standard to address for this activity.
• Use the Prior Knowledge Warm-Up Activities Template and create a warm-up activity that you will use to activate prior knowledge.
• Be ready to share your activity.


Session 2: Teacher Modeling
Learning Targets
•Define Teacher Modeling
•Practice Teacher Modeling


10 Minutes
Session 2 Warming/Opening
What is Teacher Modeling in Math?
Turn and TALK

Good or Bad Teacher Modeling?

What is Teacher Modeling?

"Modeling is demonstrating how to do something while providing an oral narrative to explain what occurred.

An example of teacher modeling is a think-aloud. The teacher verbalizes the thought processes needed to solve a problem.

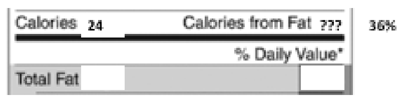
Talking through guided notes is not modeling. Student modeling can be observed/planned using fishbowl."

Dr. Mary Howe

Components of Teacher Modeling

- Provide meaningful context for problem-solving. Modeling positively impacts students who have learning problems because meaning helps students understand the conceptual process at a deeper level, and it aids in memory.
- Provide visuals to your students. Visuals provide students with reading and auditory processing problems an effective way to gain meaning from the context.
- Get students involved in reading the context. This stimulates students' involvement and enthusiasm and provides students the opportunity to be engaged in the learning process.
- Continually asks probing questions to prompt students' thinking.
- Teacher should talk with enthusiasm! It is contagious!

Teacher Modeling Example – "I-do"	What percent of 145 is 29? $$\frac{29}{145} = \frac{x}{\%}$$

Teacher Modeling Example – "I-do"	A person ate 24 calories in a day. Of these, 36% came from fat. How many calories came from fat? 

Teacher Modeling Example – "You-do" Show how you would model solving this problem to your students.	What is 24% of 135?

Teacher Modeling Example – "You-do" Show how you would model solving this problem to your students.	A hockey team won 63 out of the 84 games it played this year? What percent if the games did the team win?

Teacher Modeling Example – "You-do" Show how you would model solving this problem to your students.	Jonathan takes a math quiz and gets 45 out of 60 questions correct. What percent of the questions did he get incorrect?

Teacher Modeling Example – "You-do" Show how you would model solving this problem to your students.	In San Diego, the weather was sunny 83 1/3% of the days this past June. How many days was it sunny?

Teacher Modeling Example – "You-do"

Show how you would model solving this problem to your students.

The hockey team won 63 out of 84 games this year. What percent of the games did the team win?

15 minutes

Session 2 Closing

- What have you learned about Teacher Modeling?
- What would you do differently?

#engagemath

EDUCATION LEARNING

Day 3: Technology (6-12)

Presenter Name: Pauline Aikhuele

10 Minutes

Session 1 Warming/Opening

What is technologically enhanced scaffolding? What technology do you use in your classroom?

Technology Enhanced Scaffolding

Technology strategies for learning are:

- ❖ Games
- ❖Digital field trips
- ❖Integrating social media
- ❖Videos & Multimedia
- ❖Online Workstation
- ❖Teachers' PPTs and Smart Notebook
- ❖Sharing a class calendar electronically
- ❖Using technology for student feedback –
- ❖Computer programs for leveled learning and assessment – I Practice Math, Deltamath.com, Khan Academy, Quizizz, USA Test Prep, Knowre.

US Digital Literacy

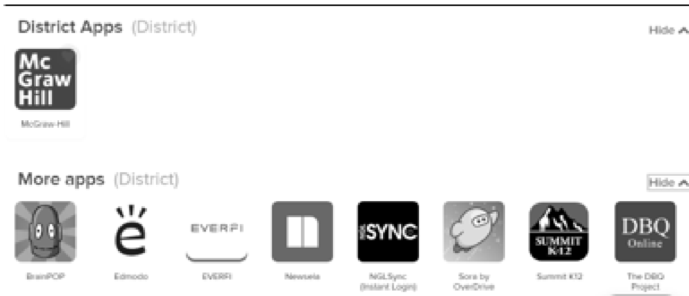
"Technology must be like oxygen: ubiquitous, necessary, and invisible."

-Chris Lehmann, Principal of Science Leadership Academy

US Digital Literacy is dedicated to providing many resources for learners, teachers, principals, parents, and ALL education stakeholders to become better equipped in today's digital world.

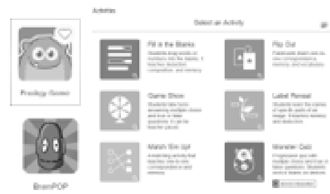
You can add digital resources via Clever

District Resources



Games

1. Games and activities on your smartboard.
2. Clever
3. Brain Pop
4. Classcraft.com



Classcraft

Don't change what you teach, supercharge how you teach it.

Classcraft is a free online, educational role-playing game that teachers and students play together in the classroom. By using many of the conventions traditionally found in games today, students can level up, work in teams, and earn powers that have real-world consequences. Acting as a gamification layer around any existing curriculum, the game transforms the way a class is experienced throughout the school year.

Playing in the Classroom

Over the course of an hour, game management occupies roughly five minutes. The Classcraft web-based and iOS platforms enable teachers and students to easily manage all the complexities of the game. The class is taught normally, and the game runs passively in the background, collecting points and managing powers. Classcraft can be played with one computer and a projector or deployed on every student's tablet or laptop.

Digital field trips

1. Discovery Education - https://app.discoveryeducation.com/learn/home
2. Internet Field Trips - http://teacher.scholastic.com/fieldtrp/math.htm

Integrating social media

- ➢Edmodo.com
- ➢Instagram
- ➢Tweeter
- ➢Diigo.com
- ➢Teacher blogs

Using technology for student feedback

- ❑Skype
- ❑Remind.com
- ❑Diigo.com

Sharing a class calendar electronically

Videos & Multimedia

- **101+ Video Sites for Educators**

http://digitalliteracy.us/video-sites-for-educators/

- **Desmos.com**

Online Workstation & Breakout Rooms

Create online or digital work stations and breakout rooms.

Teachers' PPTs and Smart Notebook

1. Record lessons on PPT and Smartboard
2. Embed videos

Computer programs for leveled learning & Assessment

- ✓Deltamath.com
- ✓Khan Academy
- ✓Knowre.com
- ✓I Practice Math
- ✓USA Test Prep
- ✓Ascendmath.com

Virtual Manipulative Programs and apps.

Table 1. Virtual manipulative programs and apps.

Virtual manipulative	Cost	Animations and corrective feedback	Grade level and content focus
The National Library of Virtual Manipulatives • http://nlvm.usu.edu	• Free (online) • Individual download: $29.95 • Multilingual download: $39.95	• Two-dimensional figures • Textual prompts • No sound effects	• Grades PK–12 • Numbers/operations, measurement, algebra, geometry, data analysis, and probability
Project Interactive •http://www.shodor.org/interactivate/	• Free (online)	• Two- and three- dimensional figures • Textual prompts • No sound effects	• Grades 3–12 and college • Aligned to NCTM • Numbers/operations, algebra, geometry, calculus, probability, statistics, trigonometry, science • For instructors: lessons, discussions, and related resources • For students: 100+ activities, assessments, textbooks, dictionary
Virtual Manipulatives—Glencoe •http://www.glencoe.com/sites/common_assets/mathematics/ebook_assets/vmf/VMF-Interface.html	• Free (online)	• Two-dimensional figures • No prompts • No sound effects	• Grades PK–8 • Numbers/operations, measurement, algebra, geometry • Background templates aligned to grade-level content (e.g., number lines, coordinate grid) • Storyboards and game boards for younger grades
Illuminations—NCTM •http://illuminations.nctm.org/Default.aspx	• Free (online)	• Two-dimensional figures • Visual prompts • Sound effects	• Grades PK–12 • Aligned to CCSS and NCTM • Numbers/operations, measurement, algebra, geometry, data analysis, and probability • Instructional plans, materials, assessments, reflection questions
Math in Focus Virtual Manipulatives—Think Central • https://www-k6.thinkcentral.com/content/hsp/math/mathinfocus/common/itools_int_9780547673844_/main.html	• Free (online)	• Two- and three-dimensional figures • Textual prompts • Sound effects	• Grades K–6 • Base-10 blocks, fractions, counters, algebra, geometry, graphs, measurement, number charts, number lines, probability • Activity-based
Desmos Graphing Calculator • https://www.desmos.com	• Free (online)	• Animations • Sliders • Color options • Web sharing • Zoom in-out feature	• Targets secondary mathematics content (Grades 6–12) • Graph functions, plot tables of data, evaluate equations, transformations, regressions
First in Math • http://www.firstinmath.com	• Individual subscription: $19.95	• Audio prompts and feedback • Two-dimensional figures • Sound effects	• Grades K–8 • Aligned to CCSS • Over 120 self-paced activities • Computational skills, decimals, fractions, rational expressions, multistep equations

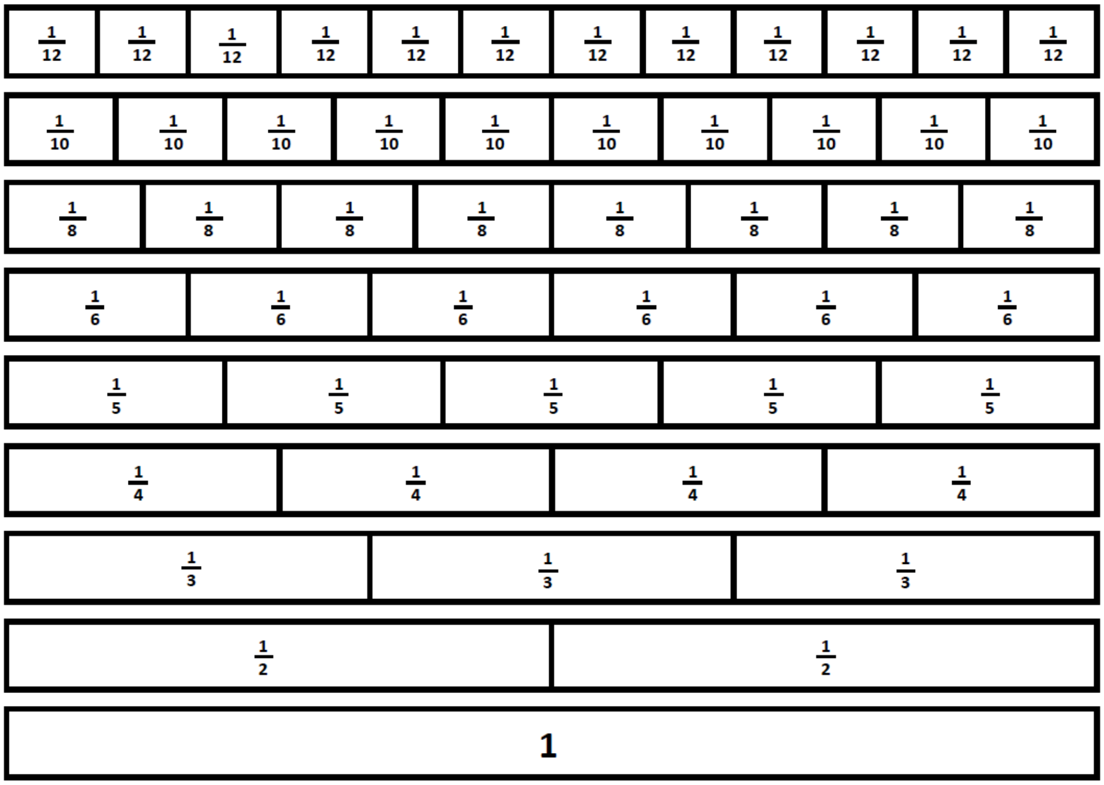
Notes. NCTM = The National Council of Teachers of Mathematics; CCSS = The Common Core State Standards (2010).

Discovery Time for Other Digital Strategies

Let's share other digital strategies and resources!


Kindly
take the
survey
Please SIGN
OUT on your
computer

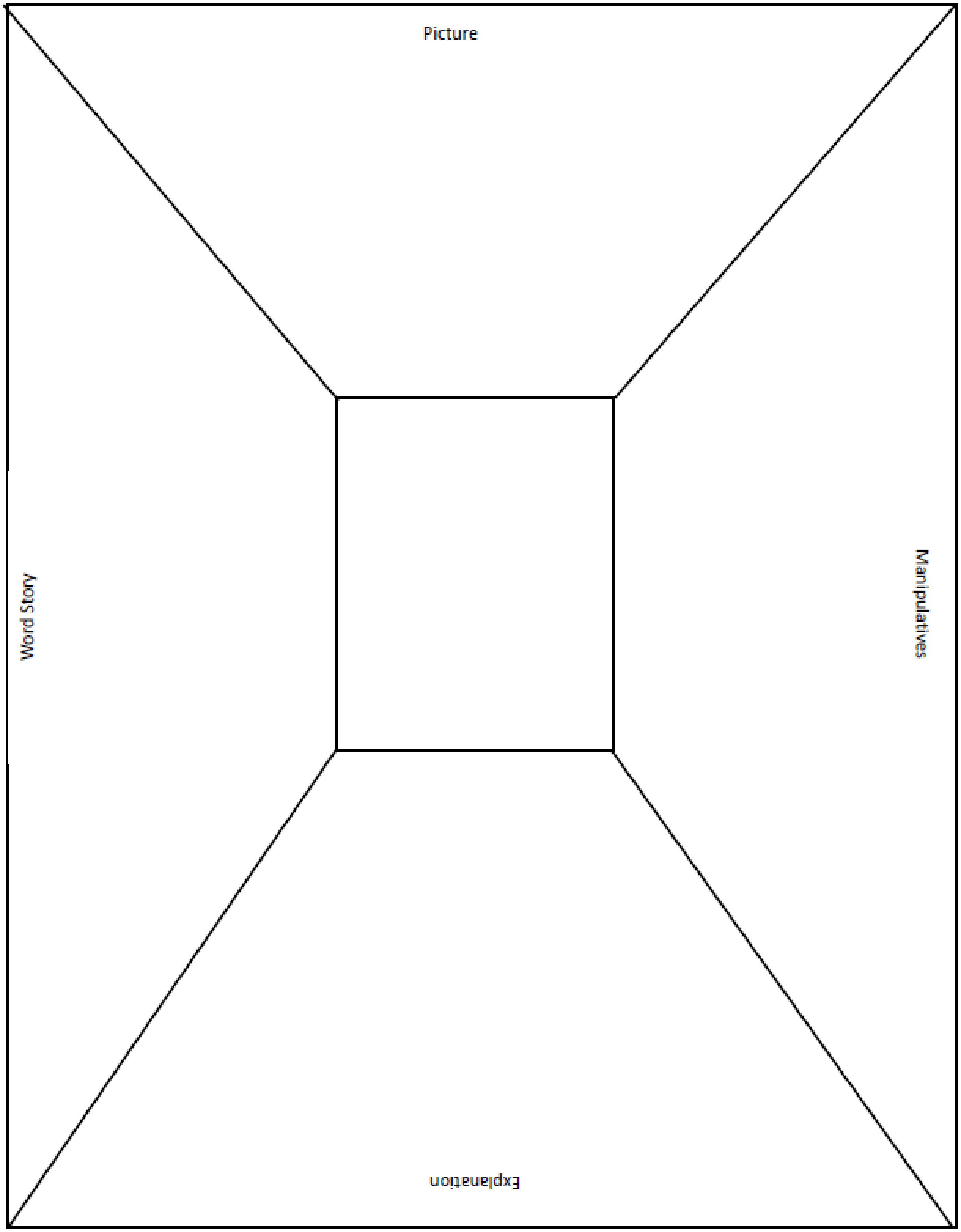
Fraction Strips (Black and White)



Multiplying fractions: Exploring fractions of fractions

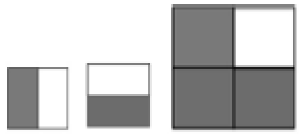
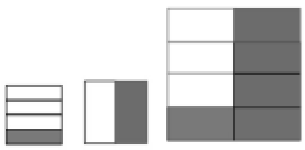
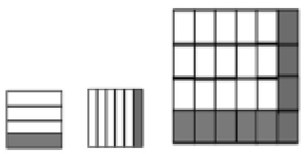
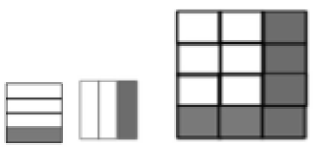
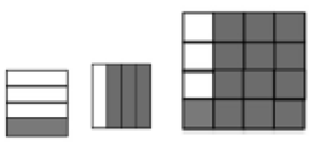
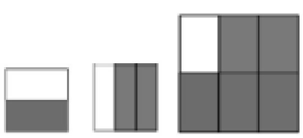
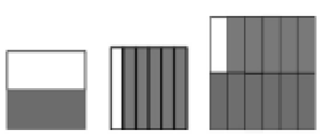
Fraction problem	Show and write the result	A story problem
What is half of one half?	One quarter 	Half of the class was in the classsroom. Half of this group were using the computers. What fraction of the whole class was working on the computers?
What is one quarter of one half?		
What is one half of one quarter?		
What is one third of one half?		
What is one fifth of one half?		
What is one half of one third?		
What is one third of one third?		
What is one half of one sixth?		
What is one half of one fifth?		

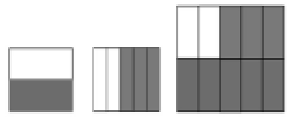
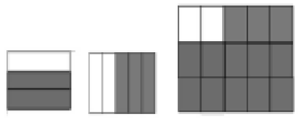
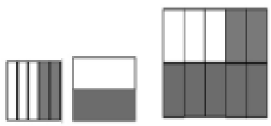
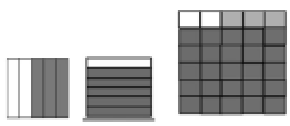
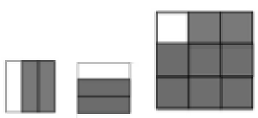
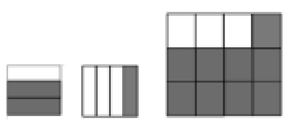
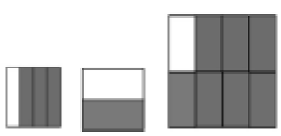
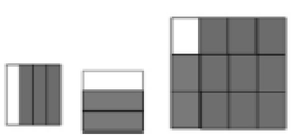
Multiplying Fractions Think Map



https://nzmaths.co.nz/

Multiplying fractions: Multiplifraction

	$\frac{1}{2} \times \frac{1}{2}$	$\frac{1}{4}$
	$\frac{1}{4} \times \frac{1}{2}$	$\frac{1}{8}$
	$\frac{1}{4} \times \frac{1}{6}$	$\frac{1}{24}$
	$\frac{1}{4} \times \frac{1}{3}$	$\frac{1}{12}$
	$\frac{1}{4} \times \frac{3}{4}$	$\frac{3}{16}$
	$\frac{1}{2} \times \frac{2}{3}$	$\frac{2}{6} = \frac{1}{3}$
	$\frac{1}{2} \times \frac{5}{6}$	$\frac{5}{12}$

	$\frac{1}{2} \times \frac{3}{5}$	$\frac{3}{10}$
	$\frac{2}{3} \times \frac{3}{5}$	$\frac{6}{15} = \frac{2}{5}$
	$\frac{2}{5} \times \frac{1}{2}$	$\frac{2}{10} = \frac{1}{5}$
	$\frac{3}{5} \times \frac{5}{6}$	$\frac{15}{30} = \frac{1}{2}$
	$\frac{2}{3} \times \frac{2}{3}$	$\frac{4}{9}$
	$\frac{2}{3} \times \frac{1}{4}$	$\frac{2}{12} = \frac{1}{6}$
	$\frac{3}{4} \times \frac{1}{2}$	$\frac{3}{8}$
	$\frac{3}{4} \times \frac{2}{3}$	$\frac{6}{12} = \frac{1}{2}$

Activating Strategies

What do activating strategies do?

- **Hook students**
- **Links to prior knowledge or build knowledge for lesson**
- **Link to lesson content**
- **Could be a preview of vocabulary**

Activity	What is it? How do you use it?
KWL Chart	A KWL chart is used prior to the study of new material, a discussion, a reading, or an event. Students are asked to brainstorm all of the things they know and want to know about a particular topic. Lastly, at the end of a unit or lesson the students record what they learned.
Wordsplash	A collection of key terms or concepts taken from the content or topic of study. The terms selected represent important ideas and vocabulary. Students make predictions and generate statements about the topic. Finally, students correct information after formal study of the material.
Anticipation Guide	An Anticipation Guide includes a list of 8-10 statements related to a topic of study. Prior to introducing new information, engage students by having them write whether or not they AGREE or DISAGREE with the statements listed on the guide. After the new content has been taught, have students react to the new information by responding again to the statement on the Anticipation/Reaction Guide. Discuss why the before and after answers may be different.
Brainstorm and Categorize	This strategy is used prior to presenting new information. The teacher introduces the topic and students brainstorm everything they know about a topic. When students have generated all of their ideas, they sort them into categories and label.
Draw a Picture or Diagram	Using a blank piece of paper, students are asked to draw or diagram and outline and details of a topic.
Activating Acrostic	Place name of a topic or concept vertically down the paper. Students generate a word or phrase that begins with each letter of the vertical word.
Dear Teacher…	Students compose a friendly letter to their teacher announcing what they already know about a topic. In the letter, students inform the teacher what they hope will be covered in the unit.
3-2-1	Students respond to the following related to a particular topic: 3 things that interest me, 2 things I'd like to know more about, 1 idea I have about the topic
Treasure Hunt – Find Someone Who Can Tell	To conduct a Treasure Hunt, students are given a description of the "treasures" they need to be located at the beginning of a unit of study. These treasures are statements about experiences or knowledge related to a new topic. As they find each kind of "treasure", they obtain a signature as verification.
Five Words – Three Words	A variation of brainstorm. Five Words asks students (working on their own) to list five words that come to mind when they think of a particular topic. Finally each group selects three words to share and explain to the entire class.
Walking Tour	To set up the Walking Tour, choose passages, pictures, or statements for a topic. Place one per chart. Number each chart and post the charts around the room. In small groups, students spend 2-5 minutes at each chart, reading, discussing, interpreting, and reacting to the idea – orally or in writing. The groups move from chart to chart until they have visited all of the charts. When the "tour groups" have finished, have the students discuss and summarize the charts with the entire group.
Picture Postcard	At the beginning of a unit or topic of study, ask students to jot down what they already know about a topic on an index card. On the first side of the postcard, students draw a picture of the topic. Revisit the postcards to check for accuracy.

www.polk.k12.ga.us

Prior-Knowledge Warm-Up Activities

Grade or Course	Grade-Level Standard	Prior-Knowledge Standard from Previous Grade, Course, or Unit
Prior-Knowledge Task Sequence		
Explanation of Task		

Adapted from Sidney, P. G., & Alibali, M. W. (2017). Creating a context for learning: Activating children's whole number knowledge prepares them to understand fraction division. Journal of Numerical Cognition, 3, 31–57

Video Links and Resources for Professional Development Sessions

1. https://youtu.be/gPAWCQ4Q0EY<iframe width="560" height="315"

2. https://youtu.be/-ApVt04rB4U

3. http://digitalliteracy.us/

Supplement 2

Scaffolding Strategies for Mathematics Professional Development Surveys

All the teachers who attend the professional development sessions should complete the survey. The purpose of this survey is to gather information regarding the quality of the professional development. The individual responses will be treated as confidential information.

The Scaffolding Strategies for Mathematics Day 1 Survey A

Question Title
***What Mathematics course do you teach**

- ☐ Foundations of Algebra
- ☐ Algebra 1
- ☐ Geometry
- ☐ Algebra 2
- ☐ Advanced Mathematical Decision Making
- ☐ Other (please specify)

Question Title
***How helpful was Scaffolding Strategies in Mathematics Professional Development session overall?**

- ☐ Very helpful
- ☐ Somewhat helpful
- ☐ Not helpful
- ☐ Did not participate

Please comment on the following regarding the sessions on Manipulatives and Visuals.

*Which session was most helpful? ____

*Which session was not least helpful? ____

*What could improve the instructional delivery of these Professional Development sessions? ____

Question Title
***The handouts and materials were adequate and useful.**

- ☐ Strongly Agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly Disagree
- ☐ Not Applicable

Question Title
***I gained knowledge and skills that will help me improve scaffolding my students' learning.**

- ☐ Strongly Agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly Disagree
- ☐ Not Applicable

Question Title
***As a result of this professional development experience, I will use my new knowledge and skills in the following ways:**

1.
2.
3.

Question Title
To continue learning about Scaffolding Strategies, I need the following:

1.
2.
3.

Question Title
***Additional Comments are welcome. Thank you!**

The Scaffolding Strategies for Mathematics Day 2 Survey B

Question Title
***What Mathematics course do you teach**

- ☐ Foundations of Algebra
- ☐ Algebra 1
- ☐ Geometry
- ☐ Algebra 2
- ☐ Advanced Mathematical Decision Making
- ☐ Other (please specify)

Question Title
***How helpful was Scaffolding Strategies in Mathematics Professional Development session overall?**

- ☐ Very helpful
- ☐ Somewhat helpful
- ☐ Not helpful
- ☐ Did not participate

Please comment on the following regarding the sessions on Activating Prior Knowledge and Teacher Modeling.

*Which session was most helpful? ____

*Which session was not least helpful? ____

*What could improve the instructional delivery of these Professional Development sessions? ____

Question Title
***The handouts and materials were adequate and useful.**

- ☐ Strongly Agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly Disagree
- ☐ Not Applicable

Question Title
***I gained knowledge and skills that will help me improve scaffolding my students' learning.**

☐ Strongly Agree
☐ Agree
☐ Disagree
☐ Strongly Disagree
☐ Not Applicable

Question Title
***As a result of this professional development experience, I will use my new knowledge and skills in the following ways:**

1.
2.
3.

Question Title
To continue learning about Scaffolding Strategies, I need the following:

1.
2.
3.

Question Title
***Additional Comments are welcome. Thank you!**

The Scaffolding Strategies for Mathematics Day 3 Survey C

Question Title
***What Mathematics course do you teach**

- ☐ Foundations of Algebra
- ☐ Algebra 1
- ☐ Geometry
- ☐ Algebra 2
- ☐ Advanced Mathematical Decision Making
- ☐ Other (please specify)

Question Title
***How helpful was the session on Technology?**

- ☐ Very helpful
- ☐ Somewhat helpful
- ☐ Not helpful
- ☐ Did not participate

Question Title
Please comment on the following regarding the PD session on Technology.
*What could improve the instructional delivery of the professional development session on technology? ____

____

Question Title
***I gained knowledge and skills that will help me improve scaffolding my students' learning.**

- ☐ Strongly Agree
- ☐ Agree
- ☐ Disagree
- ☐ Strongly Disagree
- ☐ Not Applicable

Question Title
***As a result of this professional development experience, I will use my new knowledge and skills in the following ways:**
1.
2.
3.

Question Title
To continue learning about Scaffolding Strategies, I need the following:
1.
2.
3.

Question Title
***Additional Comments are welcome. Thank you!**

Appendix B: Observation Protocol

Time of observation ______________ Length of observation _________________

Date __________________ Teacher Number ______________________

Descriptive Notes	Reflective Notes
Teacher-student Interaction:	
1. Did the teacher attend respectfully to student - comprehension or puzzlement?	
2. Did the teacher invite students' participation and comments?	
3. Did the teacher incorporate student ideas into class?	
4. Did the teacher use positive reinforcement (i.e. doesn't punish or deliberately embarrass students in class)?	
Socratic Questioning:	
Socratic Questioning:	
1. Did the teacher ask rhetorical questions?	
2. If yes, did the teacher give students time to think?	
3. Did the teacher pause after asking questions?	
4. Did the teacher draw non-participating students into discussions or to answer questions?	
5. Did the teacher prevent specific students from dominating activities/discussions?	
6. Did the teacher help students extend their responses?	
7. Did the teacher guide the direction of discussion?	
8. Did the teacher demonstrate active listening?	
9. Did the teacher provide opportunities and time for students to practice?	
Scaffolding:	
1. What is being scaffolded?	

2. How is scaffolding enacted?

3. Did the teacher activate students' prior knowledge?

4. Did the teacher offer a motivational context to pique students' interest or curiosity in the subject at hand?

5. Did the teacher break a complex task into easier, more "doable" steps to facilitate student achievement?

6. Did the teacher show students an example of the desired outcome before they completed the task?

7. Did the teacher model the thought process for students through "think aloud" talk?

8. Did the teacher offer hints or partial solutions to problems?

9. Did the teacher use verbal cues to prompt student answers?

10. Did the teacher teach students chants or mnemonic devices to ease memorization of key facts or procedures?

ZPD:

1. Do the students work in groups or in pairs?

2. How often do the students collaborate with each other?

Additional Comments:

Adapted from classroom visit 3 form : http://www.ben.edu/faculty-staff/ctle/fac_resources/forms_teaching.cfm ; ctl.gatech.edu/sites/default/files/documents/classroom_observation_checklist.docx

Appendix C: Interview Protocol

Date: ______________________________

Location: ___________________________

Interviewee: ____

The following questions/statement will serve as background questions to get the interview started.

- How long have you been teaching in this school?
- How long have you taught Foundations of Algebra (FOA) and how has been your experience?
- The purpose of this interview is to obtain information that will help me understand the various scaffolding strategies that FOA teachers utilize.

Research Questions	**Interview Questions**
Research Question 1 How do FOA teachers describe their scaffolding strategies?	1. What specific scaffolding strategies do you utilize to promote learning in 9th-grade mathematics for Foundation of Algebra (FOA) students? 2. Please explain some examples of how you use these scaffolding strategies. 3. When I observed your class earlier, I noticed …. How do you activate your students' prior knowledge?
	4. How do the strategies you mentioned help to increase students' overall achievement?
	5. How the scaffolding strategies you described help to develop students' problem-solving skills?
	6. Talk to me about your questioning strategies. How do you ask your students questions when they are struggling with a certain mathematics problem? 7. Please give an example of such a situation and the questions you asked the student(s)?
Research Question 2 How do mathematics teachers scaffold	8. Describe the ways you conduct formative assessments of 9th-grade mathematics? 9. How do you provide feedback to your students? 10. How do you know when your students have mastered a standard? 11. How do your students self-assess a mathematics concept?

learning for FOA ninth-grade students?	12. When I observed your class earlier, I noticed… How do you know that students are having difficulty on a standard before they finish an assignment? 13. Please provide an example when students had difficulty understanding a standard. What did you do to help students understand the standard?
	14. How do you utilize scaffolding to promote your understanding of students' prior knowledge before introducing new knowledge? 15. When I observed your class earlier, I noticed…You used the scaffold strategy to help facilitate the lesson. Explain how this strategy helps students work independently to use critical thinking skills and communicate with math language.
	16. Describe how you use open dialogue during instruction in the FOA classroom.
	17. Describe how you use collaboration as a strategy to scaffold your students' learning.
	18. Before we conclude this interview, is there something about your scaffolding strategy that influences how you scaffold learning of your students that we have not yet had a chance to discuss? Castillo-Montoya, (2016); Creswell, (2015).

Appendix D: Documents - Lesson Planning Protocol

1) What are the students learning?
    a. Standard
    b. Learning target/objective

2) How will the students learn it?
    a. Accessing students' prior knowledge
    b. Introducing new content
    c. Work session – Varied levels of interaction
        i. Guided practice – What scaffolding strategies?
        ii. Group practice/Cooperative learning
        iii. Individual practice

3) How does the teacher check for understanding?
    a. Monitor students
    b. Formative assessment
    c. Direct and socratic questioning

4) How will students practice beyond the class?
    a. Homework practice